DOCUMENT RESUME

ED 071 203 EA 004 817

AUTHOR	Biedermann, Konrad; And Others
TITLE	Layout, Equipment, and Work Methods for School Lunch Kitchens and Serving Lines.
INSTITUTION	Agricultural Research Service (DOA), Washington, D.C.
REPORT NO	ARS-MRR-753
PUB DATE	Dec 66
NOTE	48p.
EDRS PRICE	MF-$0.65 HC-$3.29
DESCRIPTORS	Building Plans; Design Needs; *Equipment Standards; Facility Requirements; Facility Utilization Research; Flow Charts; *Food Handling Facilities; Human Engineering; *Lunch Programs; Manpower Utilization; Performance Specifications; *Planning (Facilities); Space Classification; Space Utilization; Spatial Relationship; *Task Analysis; Work Environment

ABSTRACT

The objectives of this study include the development of (1) guides for the planning and the remodeling of new school kitchens and lunchroom facilities and (2) standards of labor utilization for three sizes of cafeterias. The data reflect the results of over six weeks of observation and measurement of operations in various school kitchens, conferences with the local school officials and food service specialists, and a review of the applicable literature. Six Ohio schools chosen for observation represented a cross section of elementary and high schools; rural and suburban communities; and small, medium, and large school lunch programs. Labor utilization was measured by the work sampling technique. In two schools, an additional day of work sampling was devoted to a separate study of the effect of kitchen layout and equipment use on actual working time versus time spent in walking and delays. Data on labor utilization were then analyzed in conjunction with information on kitchen layout, equipment inventory, and management practices. A case study was prepared on each of the six schools, and conclusions regarding potential improvements in each of the operations were discussed with local school officials. (Author/MLF)

FILMED FROM BEST AVAILABLE COPY

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
OFFICE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY

ED 071203

Layout, Equipment, and Work Methods for School Lunch Kitchens and Serving Lines

Marketing Research Report No. 753

EA 004 817

Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE

PREFACE

Material presented in this report was developed under contract by Battelle Memorial Institute. Mr. Wade D. Bash, Chief, School Lunch Program, Ohio State Department of Education, assisted in the selection of school lunch operations to be studied and counseled the contractor throughout the study. The Technical Services Branch, School Lunch Division, Consumer and Marketing Service, U. S. Department of Agriculture (USDA), assisted in planning the study and reviewing the findings. Special credit is due officials of the following six Ohio schools who made available their cafeteria operations for detailed studies: Applewood Elementary School, Brunswick; Canton South High School, Canton; Madison Jr. and Sr. High School, Trotwood; New Richmond Elementary School, New Richmond; Starr-Washington School, Union Furnace; and Troy High School, Troy.

CONTENTS

	Page
Preface	ii
Summary	1
Background	2
Objectives and scope	2
Methodology	3
Establishing Type A meal kitchen operations	3
Determining necessary size of operations	4
Basic space needs	5
Receiving area	5
Dry food storage	5
Supply storage	6
Walk-in refrigerator	6
Walk-in freezer	6
Kitchen	6
Serving area	6
Dishwashing area	7
Office space	7
Locker and toilet area	7
Lunchroom	7
General construction features	7
Walls	7
Ceilings	7
Floors	7
Doors and windows	9
Lighting, temperature control, and ventilation	9
Layout concepts	9
Flow of work	9
Materials handling	10
Effort in relation to layout	10
Equipment selection	10
Storage areas	12
Food preparation	13
Serving area	17
Dishwashing area	19
Lunchroom	19
Office and employee facilities	20
Location of equipment and layout of individual work stations	20
Work centers	20
Serving lines	21
Dishwashing	22
Observations in three sizes of school lunch kitchens	22
Characteristics of schools studied	23
Labor requirements in schools studied	24
Total labor time	24
Getting ready for meal preparation	26
Preparation and cooking of food	26
Serving of food	27
Cleanup activities	28
Incidental activities	29
Effect of kitchen layout on labor time and effort	29
Application of findings in other schools	30
Operating costs and cost control	31
Types of records and cost control	32
Pertinent cost categories and income	32
Recommended facilities, layout, and equipment	34
Facilities and layout	35
Equipment	35
Labor requirements in recommended kitchens	40
Bibliography	42
	45

Washington, D. C.

Issued December 1966

Layout, Equipment, and Work Methods for School Lunch Kitchens and Serving Lines

By KONRAD BIEDERMANN, O. WILHELMY, JR., and M. R. DULL, *Battelle Memorial Institute, Columbus, Ohio,* and JOHN C. BOUMA, *Transportation and Facilities Research Division, Agricultural Research Service*

SUMMARY

A study of six lunch operations in Ohio indicates that a thorough job of planning new kitchen facilities will pay off throughout the life of the facility in terms of reduced labor requirements. Best results are achieved in schools where the local administration draws the kitchen manager into the planning process, obtains new ideas from visits to new facilities, and formalizes requirements and plans in the form of tentative specifications. This procedure will help the food service consultant and architect in their detailed planning. Final plans should be reviewed by local school officials as well as kitchen management before being approved. In many States, the plans also can be submitted to the State department of education for review and recommendations by the School Lunch Director.

With present trends in school enrollment, facilities must be planned for growth. Incorporating a 50-percent growth potential in output into new facilities is feasible, if enough space is allotted. Economies of scale will permit a sizable increase in output in the kitchen if additional equipment can be added as needed, and if adequate aisle space is provided. Larger kitchen facilities will require less floorspace per meal than small-scale operations.

In developing the layout, including storage areas, food preparation, and serving area, planners should provide a straight-line flow of the food, with a minimum of back-tracking. Within the kitchen, work stations should be set up on a functional basis, with similar equipment being grouped together in central locations.

Selection of equipment should take into consideration its conformance to present and expected methods of operation, the extent to which it permits adherence to applicable principles of motion economy, and its speed of output. Capacity, durability, quality of construction, and price are other major factors that must be weighed when comparing one make of equipment with another.

When planning the location of equipment in the kitchen, planners should consider the equipment's accessibility from individual work stations and the total walking distance. Providing adequate aisle space for the free flow of traffic and use of mobile equipment should be given a high priority. It was determined in this study that no more than ⅓ of the total floorspace in school kitchens should be covered by equipment, with ⅔ of the total area devoted to space around equipment and traffic lanes.

Work specialization among kitchen workers was found to contribute to efficiency. Use of part-time workers during the peak hours of labor demand also reduces total man-hours of labor required when compared with a full-time staff sufficient to satisfy peak labor demands.

Average labor requirements for the preparation of Type A meals were found to range from 4.7 to nearly 7 man-minutes per meal. This includes the labor time of all people contributing to the production of meals, and represents an average output of from 9 to 13 meals per man-hour. An analysis of the variation in labor requirements relative to size of operations, layout of physical facilities, availability of equipment, management, and work methods indicated that all these factors influence labor requirements.

In the schools studied, getting ready for meal preparation required 7 percent of total labor time. This requirement is influenced by physical layout of facilities and size and location of storage areas. Food preparation and cooking took 26 percent of total labor time. Size of operations significantly influences per-meal labor requirements in this category. Serving of food took about 23 percent of labor time.

Good layout of the dishwashing facility and speed in the flow of operations help keep labor requirements for cleaning low. Incidental activities took 17 percent of total labor time. Most of this time is for administration and planning. A reduction of effort in this category is not likely to lead to an overall lowering of labor requirements.

A breakdown of labor time of kitchen workers by activity showed that 65 to 75 percent of total labor time is spent in actual work accomplishment. Between 15 and 25 percent of total time is spent walking, 9 to 12 percent is consumed in delays, and 1 to 2 percent goes for personal needs and time unaccounted for.

Another major area affecting operational success in school kitchens is cost control. Cost accounting that concentrates on the recording and analysis of *current* data and performance is most helpful in maintaining operational control. It enables managers to pinpoint causes of potential trouble and the extent of improvement that can be expected from certain remedial actions.

Differences in local situations make it impossible to follow exactly any standard set of recommendations in planning and operating local school lunch programs. However, for demonstration purposes, principles and experiences of schools discussed in this report have been combined into a description of recommended facilities and labor utilization for three sizes of school lunch operations.

BACKGROUND

Since 1946 the U. S. Department of Agriculture, through the National School Lunch Program, has endeavored to provide a maximum number of children with nutritious school lunches. During the school year 1963-64, 16 million school children consumed about 2.7 billion lunches, prepared in approximately 68,000 school kitchens throughout the United States. The rapid increase in numbers of school-age children expected in future years will increase the number of lunches.

With the continued growth of the school lunch program the need for information to help the management of school lunch operations, in addition to that published on the storage of food and the planning and equipping of lunchrooms, became apparent. This study was initiated in 1963 in cooperation with the School Lunch Division, Consumer and Marketing Service, to develop standards of labor utilization and guides for planning or remodeling kitchens and lunchrooms in schools with kitchens on the premises. With application of results in this study, it will be possible for management to improve the efficiency and reduce the effort required to prepare and serve Type A lunches in existing schools and to avoid many of the inefficiencies caused by improper planning in new kitchens.

OBJECTIVES AND SCOPE

The objectives of this study include the development of (1) guides for planning of new school kitchens and lunchroom facilities and for major remodeling of such facilities, and (2) standards of labor utilization for three sizes of cafeterias.

When the data presented in this report are being applied to local conditions, the limitations of the study should be taken into consideration. Observations of school lunch operations, on which the report is based, were limited to local kitchen operations, as opposed to central kitchen operations. This means that equipment data and labor requirements reported for various sizes of operations apply to situations in which meals are prepared and consumed at the same location. However, principles governing kitchen layout and labor utilization will apply to central kitchen operations in most instances.

Another factor to be considered in applying the research results is that all of the schools studied served Type A meals primarily or exclusively. To qualify as a Type A lunch, a meal must contain as a minimum the following: (1) One-half pint of fluid whole milk as a beverage. (2) Two ounces (edible portion as served) of lean meat, poultry, or fish; or two ounces of cheese; or one egg; or one-half cup of cooked dry beans or peas; or four tablespoons of peanut butter; or an equivalent quantity of any combination of the above-listed foods. To be counted in meeting this requirement, these foods must be served in a main dish or in a main dish and one other menu item. (3) A three-fourth cup serving consisting of two or more vegetables or fruits, or both. Full-strength vegetable or fruit juice may be counted to meet no more than one-fourth of this requirement. (4) One slice of whole-grain or enriched bread; or a serving of cornbread, biscuit, rolls, muffins, etc., made of whole-grain or enriched meal or flour. (5) Two teaspoons of butter or fortified margarine.

This study centered on operations providing the Type A meal program since it assures a nutritionally well-balanced meal. However, data in this report can be used by a local school serving a limited number of food items on an a la carte basis in addition to a Type A meal.

METHODOLOGY

Information obtained in this study came from several sources. The greatest part of the data came from more than 6 weeks of observation and measurement of operations in various school kitchens. Conferences with local school officials and food service specialists provided additional information, and this was supplemented by a review of the literature and applicable industrial engineering principles.

The six schools chosen for direct observation are in Ohio. They represent a cross section of elementary and high schools, rural and suburban communities, and small, medium, and large school lunch operations. Local school officials cooperated fully in making available all pertinent information and permitting direct observations and measurement of physical operations for an entire week, during which a standardized menu was served.

Labor utilization was measured by the work sampling technique (*3*).[1] In this study, 16 different and clearly distinguishable tasks were defined beforehand. The minimum number of observations that will achieve a 90-percent accuracy in the time reading for a task that takes 10 percent of total labor time was determined to be 2,500. In the larger schools, this number of observations was exceeded substantially. In two schools, an additional day of work sampling was devoted to a separate study of the effect of kitchen layout and equipment use upon actual working time versus time spent in walking and delays.

Data on labor utilization were then analyzed in conjunction with information on kitchen layout, equipment inventory, and management practices. A 30- to 40-page case study was prepared on each of the six schools, and conclusions regarding potential improvements in each of the operations were discussed with local school officials. When the final report was drafted, information collected during the field work was combined with the results of a review of pertinent literature and facility and equipment specifications.

ESTABLISHING TYPE A MEAL KITCHEN OPERATIONS

School lunch programs at the local level are complex operations involving the highly specialized functions of planning and preparing of meals, as well as the serving of food that will broaden students' dietary interests. One of the essentials of a successful school lunch operation is adequate facilities. Since, once established, these facilities have a long-range influence upon the physical efficiency, special attention must be paid to their planning.

The subjects discussed in this section are indicative of the general areas to which attention must be given. Their diversity points to the need for drawing into the planning sessions a number of different talents. The school board and administration are in the best position to assess needs of present and future sizes of feeding operations. They also are the ones most aware of the overall requirements that must be met during a construction or expansion program and the budgetary limitations. Lunchroom supervisory personnel and kitchen workers have considerable experience that can be valuable in translating the information provided by the school administration into the necessary space and equipment requirements.

As a source of new ideas, inspection of school lunch facilities recently constructed can be of great help to lunchroom supervisors and school administrators. Such visits before or during the planning of a new facility provide an opportunity to observe the new layout in operation, to exchange information, and to benefit from the experience of the users. Another planning aid that can be effectively used is a tentative outline of the general floor plan, with movable templates representing the individual pieces of equipment that must be fitted into the layout. Although both the floor plan and the templates should be approximately to scale, these tools need consist of nothing more than paper cutouts of the proper size (*8*). Some time and deliberation will be needed to arrive at a satisfactory arrangement.

The more local officials analyze needs and translate them into a list of objectives and means of achieving these objectives, the more effective will be the work of a food service consultant in developing more detailed plans and specifications for the kitchen and allied service area. A consultant or architect will prepare a scale drawing or blueprint and a set of specifications describing in detail the number, size, quality, and other characteristics of the facility and equipment to be installed.

At this point, and before making final plans, architects and food service consultants usually

[1] Italic numbers in parentheses refer to the Bibliography, p. 45.

will review the plans with all persons involved. Inclusion of the lunchroom supervisor and her assistants in this review session is important. Some time will have passed since these people were asked to submit their initial suggestions, and they may have additional ideas that should be incorporated into the final plans. Furthermore, letting the future users of the facilities familiarize themselves with the plans at this stage will make them feel that they have had a part in the planning. In the long run, this is bound to increase the overall effectiveness of employees and their alertness to opportunities for improving work methods.

There are other aids available to local school officials who are planning expansion or remodeling of physical facilities for the school lunch program (*6*, *8*, and *9*). Additional information can be found by tracing references quoted in reports, books, and articles. The school lunch division of the appropriate State department of education has people available who, through their basic training and constant contact with school lunch operations throughout the State, have developed valuable knowledge and experience. They are usually available to discuss proposed plans with local officials and will point out shortcomings and make constructive criticisms at a stage where revisions can still be incorporated in the plan.

In two of the kitchen facilities studied, initial planning involved what may have appeared at the time a disproportionate amount of detail and effort. However, this joint effort of local school officials, consultants, and architects resulted in facilities that, even after several years of use, have given rise to very few desires for changes on the part of kitchen personnel. Furthermore, even at a meal load of nearly twice that experienced at time of construction, the kitchens are operating efficiently and show little evidence of crowding.

At the other extreme, in two other kitchen facilities studied, the operations evidently had been fitted into whatever space was left after all the needs of other departments had been met. This resulted in unsatisfactory arrangements in total space and layout and higher labor requirements. In these kitchens, the burden of achieving a satisfactory performance in daily operations has to be carried entirely by the kitchen personnel. However, good management and the diligence of kitchen workers compensated for the unsatisfactory layouts.

The following detailed comments on planning steps include some information provided in a previous U. S. Department of Agriculture publication (*8*). Some of the previously published information is included (1) to emphasize that these data, though originally developed in 1956, were verified by the current study with a few exceptions; (2) to extend some of the data to school lunch operations serving more than 1,000 meals per day; and (3) to provide a proper framework for the later discussion of the interaction of facilities and labor efficiency.

Determining Necessary Size of Operations

When considering the number of meals a kitchen facility will be expected to provide, planners should keep in mind the basic objectives of the school lunch program. The express intent of the program is to provide students with nutritious and well-balanced meals and to make lunch at school an educational experience. Therefore, physical efficiency and budgeting are not the only factors to be considered.

One of the most widespread defects of school lunch facilities is that they are too small for the number of students to be served. This stems from budget limitations and too low an assessment of the growth trends in school enrollment, which led to construction of kitchen facilities that did not provide for growth.

Experience has shown that it is feasible, in spite of the usual budget limitations, to plan kitchen and lunchroom facilities that could handle a 50-percent increase in the number of meals served. Thus, in communities where school enrollment trends forecast a marked increase in the use of facilities, planning should provide for expected growth in the next 5 to 10 years.

Another factor influencing the size of facilities is the student participation in the lunch program. This is governed by the type of lunch program offered, the variety and appeal of menus served, alternative eating opportunities available to students, and practices in the scheduling of lunch periods. In many schools, average daily participation of students is less than 50 percent of enrollment. In other schools with favorable circumstances, as high as 90-percent participation has been attained.

There are other trends in public school administration that will influence lunch program participation by pupils. Increasing pressure upon school facilities requires closer scheduling in the use of facilities and available teachers. More schools are likely to require students to remain at the school during the lunch period and more staggered lunch periods are likely to be used. These developments will tend to channel upper grade students who presently leave the school grounds during the lunch period into the lunchroom serving lines. But it also will call for an increased variety in menus and at least a limited choice among food items.

Other factors that will influence the size of planned operations relate to other uses to which the facilities are to be put. These other uses will affect the size of the lunchroom more than the size of the kitchen. Thus, a relatively small school with low student participation in the lunch program may have a large lunchroom with adequate space for other school activities, such as use as a study hall.

In the kitchen, certain economies of scale help provide for a potential increase of 50 percent in the meal load. As the number of meals served increases, the required kitchen area per meal can be reduced up to a certain point without reducing efficiency. Adequate traffic aisles and room for the proper placement of a few pieces of additional equipment can suffice in planning for a 50-percent increase in meals prepared.

Consideration of present and expected future school enrollment, student participation in the lunch program, and other uses of the facilities must be translated into basic space needs.

Basic Space Needs

Adequacy of space will influence operating costs of a school lunch facility as well as initial building cost. When space is too small, labor time and effort will increase. On the other hand, when the facility is too large, walking distances between work stations are unnecessarily long, and building and maintenance costs are excessive. With only a few exceptions, however, the tendency in the past has been to allow too little rather than too much space.

Throughout the following discussion, frequent reference is made to small, medium, and large school lunch operations. While these are flexible definitions, for the purpose of this report they refer to kitchens providing less than 500 meals a day, between 700 and 1,000 meals per day, and more than 1,400 meals a day, respectively.

Receiving Area

The receiving area for food and general supplies should include an outside loading platform easily accessible to delivery trucks and an inside area that permits checking incoming shipments without interfering with normal operations.

The outside loading platform should be at truckbed height, and at the same level as the floor of the receiving and storage areas. A truckbed height dock may be achieved by lowering the driveway, but proper draining should be provided at the lowest point. The platform, or dock, should be at least 6 feet deep, and a roof should extend over the entire platform. The roof must be high enough for the door openings and for the delivery trucks, which may be as much as 13 feet.

Schools serving up to 500 lunches a day and receiving frequent delivery service may need only a 6- by 10-foot outside platform. Schools feeding more than 700 students may want space for delivery by two trucks at the same time; two trucks could be accommodated by a platform measuring approximately 8 by 20 feet.

Similar variation is found in the size of inside receiving areas. In a small school, this room should be at least 50 square feet in size. In a large school, it should be approximately 100 square feet for rapid unloading. This space does not include room for a passageway, if the entrance to the kitchen leads through the receiving area. Furthermore, in a large school, proportionally less room will be required for holding cartons and cans because these items are likely to be picked up more frequently. If trash is not picked up daily, and if food waste is hauled away rather than run through garbage disposers connected to the sewer system, extra space totaling 50 square feet will be needed for a garbage can rack and can wash area. This should be adjacent to the receiving room.

Of the six schools studied, only one had a separate receiving room. The others used the rear hallways as temporary holding areas for incoming supplies, or moved the supplies directly into the storage room. If the passageway from the rear door to the kitchen was not blocked by the incoming supplies, this practice did not influence labor requirements adversely, nor did it conflict with recommended sanitary or safety practices. More extensive discussion on the receiving and storage areas is provided in other USDA reports (*8* and *9*).

Dry Food Storage

Under normal conditions, 0.5 square feet of floorspace per meal served daily has proved to be adequate for orderly storage of food not requiring refrigeration. This figure is based upon approximately 2 weeks' supply of staples; it permits use of part of the area for storage of paper goods and other items not conflicting with sanitation and safety practices governing the storage of dry foods. This study, however, did not include a specific investigation of the optimum level of supplies that should be carried by schools.

There is a tendency to underestimate the need for storage space in school lunch operations. For this reason, it is emphasized that the space requirement of 0.5 square feet of floorspace per meal served daily for storage should be applied to the average number of meals after allowing for growth of school enrollment and meal par-

ticipation. Adequate ventilation should be provided in the dry food storage room.

Supply Storage

A separate room for the storage of cleaning supplies is required because these materials cannot be stored in the same room with food supplies. In small kitchen operations, this separate room could be closet space in the receiving area. In this case the overall size of the receiving area must be somewhat enlarged. For larger schools serving up to 2,000 meals per day, a separate room providing 120 square feet should be sufficient. This room should have a sink with hot and cold water and adequate ventilation, though a window may not be necessary. If space in the dry food storage area is limited, paper goods may be kept here also.

Walk-in Refrigerator

Observation of school lunch operations in small schools indicates that a walk-in refrigerator is very desirable. However, no effort was made to verify the exact size of operation where cost of equipment and floorspace occupied by reach-in equipment would begin to exceed the cost of the smallest walk-in refrigerator that can be recommended.

Walk-in refrigerators with less than an 8- by 10-foot inside dimension will not be large enough for workers to turn around when restacking shelves. Furthermore, units with a floor level that will not permit the wheeling of loaded carts into the unit will reduce the efficiency and use of refrigerated space. On the other hand, walk-in refrigerators with 150 square feet of usable space, at the same floor level as the kitchen, were adequate for the needs of kitchens serving from 1,400 to 2,000 meals a day.

Walk-in Freezer

Proper size of walk-in frozen food storage depends upon the location of the school, food purchasing practices, and frequency of deliveries. For these reasons, it is difficult to give an accurate indication of size of operation beyond which reach-in freezers should be replaced or supplemented by walk-in space. The minimum practical size of walk-in freezers is approximately 8 by 10 feet.

In the schools studied, use of commercial freezer space away from the school was not considered a good solution to the problem of providing additional space. Furthermore, provision of freezer space on the basis of average need is inadequate, because USDA-donated frozen meat and poultry must be accepted at the times and in volumes allocated. A large school lunch operation might find a walk-in freezer providing 100 square feet of floorspace adequate.

Kitchen

The floorspace needed for preparation and cooking of food is more subject to reduction in square footage required per meal than other areas. In small operations serving up to 200 meals a day, the 2 to 2.5 square feet of kitchen floor area per meal served daily, as recommended in earlier publications, is definitely necessary to provide adequate working space (*8*). Yet, with 350 to 500 meals a day, 1.5 square feet per meal served daily was found to be sufficient. For more than 1,000 meals, one square foot can prove quite adequate, and for as many as 2,000 meals per day, 0.8 square foot of floorspace per meal served daily will still permit a layout that allows the free flow of traffic.

This is not meant to imply that kitchens built during the last few years are too large, because the contrary appears to be true. Of the six schools studied, only two came close to the above recommended standards. The others were crowded for space.

Serving Area

The amount of floorspace that must be allotted to the serving area depends primarily upon the number of serving lines installed; this in turn depends upon the length of the noon hour and the schedule for releasing individual grades for lunch. A straight-line serving counter incorporating separate sections for hot and cold food, milk, tableware, and the cashier will extend from 20 to 25 feet. To provide adequate aisle space for students and servers, 200 to 250 square feet of floorspace is required. An L-shaped arrangement of the serving line takes slightly more floorspace.

Serving speeds observed ranged up to 8 students per minute during periods when there were no breaks in the line. However, the average speed, with serving lines remaining open for 1 hour and 40 minutes, was approximately 5 students per minute per serving line. At this rate, one line can be expected to serve up to 500 students in 1 hour and 40 minutes. Only extremely close scheduling, staggered release of individual grades, and an extension of the total lunch period beyond 2 hours would permit serving as many as 700 students per serving line, as was observed in one school.

Dishwashing Area

Orderly arrangement of a small dishwashing layout with a tank-type automatic dishwasher will require approximately 150 square feet. This will be adequate for kitchens serving as many as 500 meals per day. At the other end of the scale, a much higher capacity automatic dishwasher will require from 250 to 300 square feet of floorspace and can handle as many as 2,000 meals per day.

Office Space

At least 60 square feet is needed to provide suitable office space for the head cook or the lunchroom supervisor. If the jobs of the head cook and lunchroom supervisor are filled by different persons, office space for both should be provided. This will require 120 square feet.

Locker and Toilet Area

Locker room space of approximately 3.5 square feet of floor area should be provided for each employee. Together with a toilet facility, this will require a room with about 60 square feet for a lunchroom serving 300 to 500 students. In a kitchen serving 1,400 meals per day, 160 square feet is adequate for the same type of facilities.

Lunchroom

In general, most school lunchrooms allow 10 to 12 square feet of floor area per person seated at one time. In elementary schools, 9 square feet per person is adequate. Most schools extend their lunch periods so they can accommodate at least two seatings daily. The number of seats needed would be approximately one-half the number of meals served daily. Close scheduling can permit as many as four seatings daily, but achievement of this depends upon optimum performance in the kitchen and extremely close scheduling of individual grades as they move through the serving line.

These guidelines to basic space requirements for school lunch facilities were not developed by any scientific estimating technique, but rather by observation of actual operations covering a wide variety of situations. They are intended as an initial planning guide. Since some of the space requirements are subject to State and local regulations, such regulations must be taken into account before the plans are completed. Architects and consultants are familiar with such regulations and can also draw upon experience accumulated under comparable conditions.

Figure 1 shows approximate space requirements for the major areas for various sizes of school lunch facilities. Lunchroom space requirements are not shown in figure 1 because such space depends upon the number of seatings per day and alternative uses for the room.

General Construction Features

Final specifications of materials for the facilities are made by the architect. Exterior features of construction will be governed largely by the style and architecture of the entire building; they are beyond the realm of this report.

Interior features, especially the selection of materials, should be viewed in terms of functionality and durability of materials, sanitation and ease of cleaning, and cheerfulness of the resulting atmosphere.

Walls

Walls should be smooth, impervious to moisture, and easy to wash and keep in good repair. For these reasons, glazed tile is widely used. Painted plaster or masonry is acceptable for areas not subject to splashing and daily washing, such as storage room, office, and locker room walls, and certain parts of the kitchen walls above a height of 6 to 7 feet. Plasterboard or wood is not desirable because it is not verminproof. Covered bases at the floor line are necessary for easy cleaning, and coved vertical corners may be required by local regulations. Metal corner guards, preferably stainless steel, should be installed on all projecting corners subject to traffic damage. Light colors are preferred for walls and ceilings.

Ceilings

In the kitchen, ceilings should be smooth, impervious to moisture, and easy to clean and repair. Nonabsorbent, rodentproof, fire-resistant, acoustical-type ceilings are desirable. A mechanical suspension system for such ceilings is less affected by steam and heat than adhesive attachment of acoustical materials. Painted, waterproof, mildew-resistant plaster or cement is performing satisfactorily in some schools with good ventilation and exhaust systems.

Floors

Nonresilient flooring, such as ceramic tile, terrazzo, quarry tile, or slip-resistant treated concrete, are more durable than resilient types of flooring. However, if used in work centers of the kitchen, they require the use of synthetic

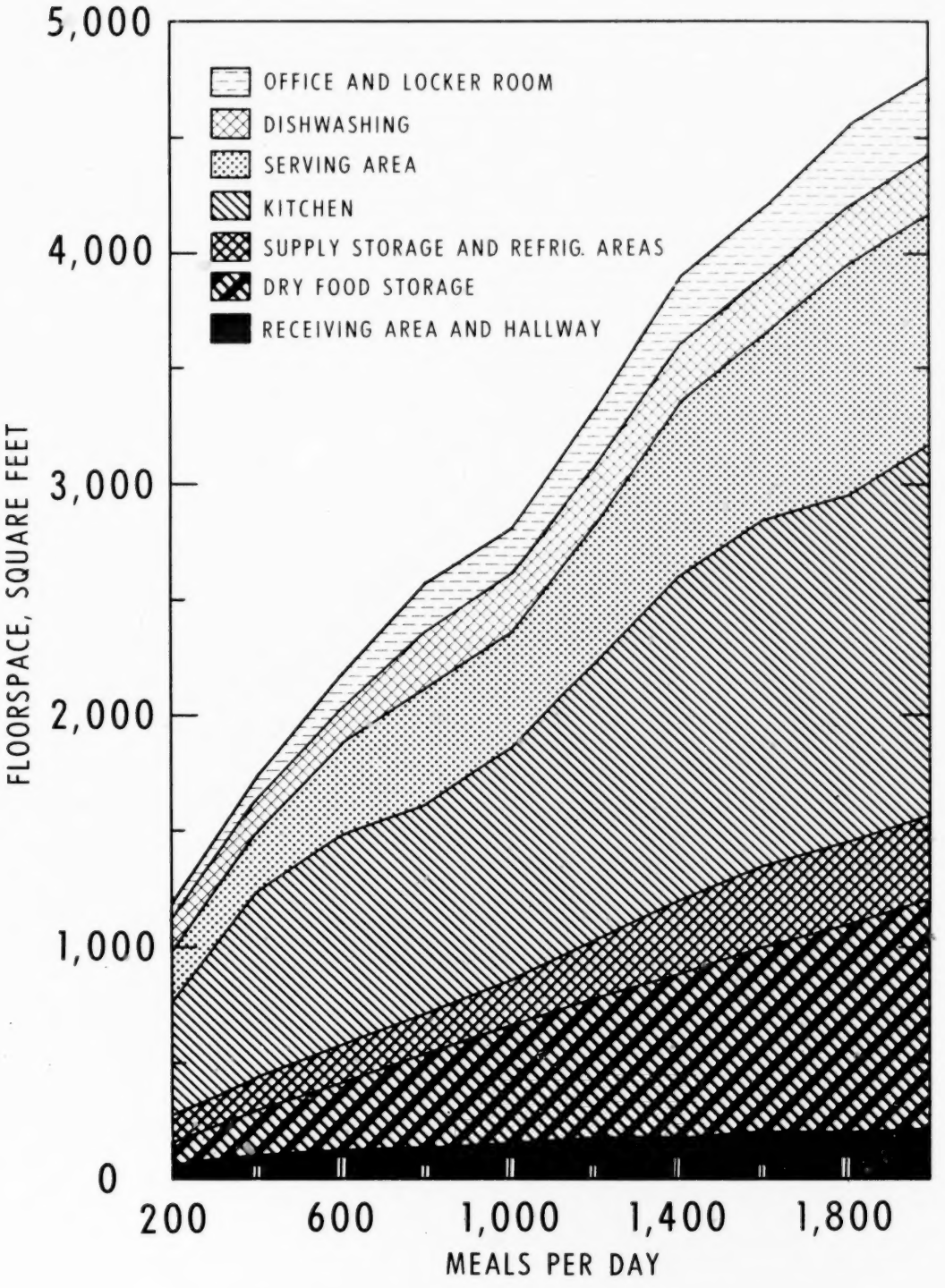


FIGURE 1.—Approximate space requirements for operating areas in various sizes of school lunch facilities.

rubber or vinyl mats to reduce worker fatigue. Resilient flooring must be slip-resistant, grease-, acid-, and alkali-resistant, and easy to keep clean. Vinyl-asbestos, greaseproof asphalt, and rubber tile are some of the types that have proved satisfactory.

Recessed floor drains away from work areas are desirable in the kitchen, serving, dishwashing, and receiving areas. If used in dry food storage areas, they must be constructed so that no vermin or rodents can enter the area through them. Floor areas under steamers, kettles, and can-washing equipment should be surrounded by curbs or gutters and drained independently of other floor areas.

Doors and Windows

Outside doors should have self-closing devices and locks. Inside doors should have locks and should provide a sound-dampening effect. Doors leading from refrigerated or other self-contained rooms should have locks that can be opened from the inside. Metal door frames are desirable to minimize damage from daily traffic.

Windows should provide ventilation without causing undesirable drafts. They also should be high enough (48-inch sill height) to permit alignment of equipment along outside walls. Some kitchens have been constructed with only a skylight or with no windows at all. If proper mechanical ventilation is provided, many workers will get accustomed to the situation. Other workers will feel unhappy in a room without windows. From a strictly functional viewpoint, there are no basic objections to a kitchen in the center of a building, without windows.

Lighting, Temperature Control, and Ventilation

Detailed standards have been developed on acceptable levels of lighting, temperature control, and ventilation in kitchens. Architects are familiar with them as well as with local regulations, and are often in the best position to prescribe the proper features of construction and equipment.

Experience has shown that the mechanical ventilation system of the kitchen should be separated from that for the rest of the school. The kitchen and service areas can be heated by the school heating system but must have a separate temperature control. Dry food storage rooms should be vented toward the outside of the building both at a high and low point.

Lighting and wiring must comply with the National Electric Code and local requirements. Light fixtures should be so placed that employees will not work in their own shadow and will not be inconvenienced by glare. Provisions should be made in the initial construction plans for special wiring and outlets for heavy-duty equipment. Spare circuits should be incorporated for future needs. Although there should be easy access to critical points in utility lines, exposed conduits, pipes, and other surfaces difficult to keep clean should be avoided.

Layout Concepts

In most schools, the pattern of the entire building will determine the general location of the kitchen and lunchroom facility. Beyond that, the facility should be arranged for efficiency of operation. Industrial engineering techniques used in this study included time studies, observation of equipment use, attention to principles of motion economy, and observation of the effect of working conditions upon worker fatigue. The results indicated the importance of studying the functionality of the general layout of a kitchen facility before construction.

Flow of Work

The term "layout" in this discussion refers to the relation of the general work areas to each other. The overall flow of work should be straight line as used in assembly-line production, with storage at the beginning or end, and with delays kept to a minimum. Straight line in this sense means that the flow of material being processed is continuous or direct in progress. In actuality, the layout may be circular, U-shaped, or L-shaped or in parallel lines.

Local school officials may draw a diagram showing the overall flow of supplies and products from one area to the next with arrows to indicate the direction of flow. Later, the flow may be imposed upon a copy of the blueprint supplied by the architect. The arrows may be different colors to indicate specific operations, such as green for raw materials, red for prepared foods, and blue for dishes. The diagram will show whether relocation of a certain section is needed.

Figure 2 shows a diagram of a desirable relationship among the major service centers. In small and medium-size kitchen operations, where rectangular space with length not more than about twice the width is available, it is usually possible to come close to an ideal arrangement of the major work centers. In larger operations, serving up to 2,000 meals per day, distances become more critical because of the size of the operation, and certain compromises

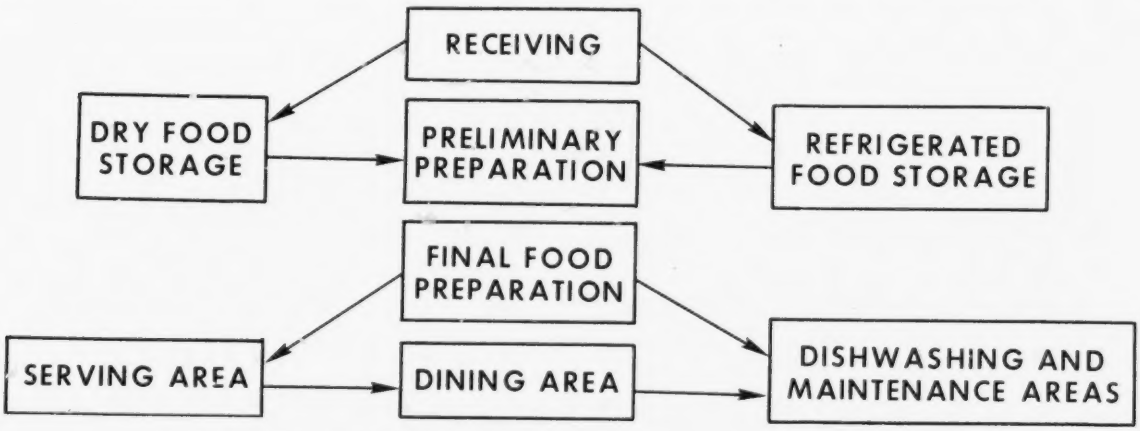


FIGURE 2.—Desirable location of major service centers in relation to each other *(8)*.

may be necessary. Compromises made depend upon the frequency of use of the specific area, and the amount and bulkiness of items that must be transported. Thus, it usually is better to locate the supply storage and maintenance areas farther from the direct line of flow than the dry food storage or the refrigerated areas.

In this study, managers pointed out that more than one outside door for deliveries often leads to confusion and therefore is not as desirable as a well-planned layout with one delivery door for all types of foods and supplies.

Materials Handling

The time and effort that must be expended in handling food and supplies as they move through the facility is influenced by the overall layout.

The handling of foods and supplies by a worker at one work station is influenced by methods of operation and can be adjusted to some extent after the kitchen is in operation. Materials handling that deals with the flow of food and supplies among areas is more difficult to adjust after the kitchen is in operation. If aisles and doors are not wide enough and the traffic pattern crisscrosses, even the use of the most functional dollies, carts, and handtrucks will not alleviate the basic problem. However, if size and layout of physical facilities is well planned, aids in transporting heavy or bulky items (including small worktables and equipment stands with lockable casters) can keep the materials-handling problem manageable. This is especially important in school kitchens, since the work is usually done by women, and men may not be available for assistance in heavy lifting.

Effort in Relation to Layout

One measure of the effort of kitchen workers that can be used to assess the relative effect of layout on labor time is the percent of total working time spent walking. This is significantly affected by the size of the facility and the degree of specialization of kitchen workers. However, even with aisles of adequate width, with cooks specializing in the preparation of different categories of food, and with all service areas within the same rectangular complex, cooks still must be expected to spend approximately 15 percent of their working time walking from one area and work station to another.

Actual measurement in two large kitchens indicated that this percentage can be as high for kitchens with narrow aisles and more remote storage areas as for very spacious kitchens in which the flow of product involves significant backtracking. From data obtained during this study, there probably are many school kitchen layouts where up to 25 percent of total working time is spent in walking, which in turn increases total labor time for the preparation of meals.

Equipment Selection

The following are the foremost considerations in the selection of equipment for school lunch operations: (1) Does the equipment fit present and expected methods of operations? (2) Does it permit adherence to applicable principles of motion economy? (3) Does it permit speedy output? (4) Will the increasing cost of kitchen labor make the use of convenience foods more attractive in the future, and thus eliminate the need for some equipment?

Methods of operation can vary considerably among school kitchens serving meals meeting Type A specifications. Thus, a school system offering hot plate lunches to students will select different types of equipment than those serving only bag lunches. Within the group serving hot meals, for example, an examination of reasons offered for the increased use of steam cooking equipment might lead to a change in cooking methods. Decisions of this type are of a long-range nature, and a good time to consider future applicability of present methods is when new facilities are being constructed and new equipment selected.

Another point on which technical data on new equipment alone cannot shed sufficient light is "How easy is the equipment to operate?" This will depend upon such factors as these: Are working surfaces adjustable to the proper heights for various sizes of people? Are controls and switches within easy reach? Can momentum be used to advantage during the operation, or is it reduced to a minimum at stages where it must be overcome by muscular effort? Can both hands be used simultaneously? Many of these questions can be answered only after actual use of equipment. This is another reason for visits by lunchroom personnel to other school kitchen facilities that use the equipment contemplated.

With emphasis on fuller utilization of physical facilities, speed of operation and quantity of output of equipment deserve special attention. The trend toward school consolidation has decreased the number of school lunch operations serving less than 300 students. In larger operations, the use of more specialized equipment is justified. This equipment is usually capable of turning out more product in less time with lower labor requirements than multiple-purpose equipment. A case in point is the use of deck ovens in place of ovens incorporated into range units.

Rising labor costs will have a dual effect upon equipment requirements. On one hand, mechanization of tasks will become even more desirable and call for additional equipment. On the other hand, a continued increase in the cost of labor for local preparation of foods will speed the development of more convenience foods that could lower both labor requirements and equipment needed in school kitchens. For example, under some circumstances it may be more desirable to use powdered potatoes than to buy a potato peeler and use kitchen labor to prepare the potatoes. In each case, the costs involved must be carefully weighed.

Other considerations in equipment relate to the materials used in construction of the equipment, technical design features that promise low upkeep, quality in construction, safety and sanitation aspects in operating the equipment, and cost of operation. Within the cost ranges commonly encountered in first and installed cost of comparable equipment, any or all of the considerations can alter which make and model should be considered. What looks like a bargain price may turn out to be less attractive after long-run aspects are taken into consideration, and a more expensive piece of equipment featuring functionality, quality, and low cost of operation may be the best buy.

Internal conditions also play an important role in the selection of equipment. One of these is the availability of utilities and services. In areas not serviced by public gas, water, and sewer systems, certain types of equipment may be out of the question, and operating requirements of such equipment (for example, water requirements) will need much closer scrutiny than in other schools.

There is such a variety of equipment on the market that a fair rating of each on all important counts would require a tremendous amount of study. Furthermore, technical advances would require a constant updating of this information. There are, however, impartial guidelines that can aid local school officials in the selection of kitchen equipment. One such guideline is the standards established and published by the National Sanitation Foundation, a nonprofit, noncommercial organization composed of industrial and public health leaders.

This organization is seeking solutions to all problems involving cleanliness. A piece of equipment that meets these standards will probably permit sanitation commensurate with the best knowledge available at the time. Other aids in the selection of equipment are the experience and professional knowledge of food service consultants, and the reputation developed by the manufacturing firms.

Since differences in local conditions make discussion of the relative merit of specific pieces of equipment of limited value, the following discussion of equipment commonly used in a school lunch operation has been kept in general terms. Comments are based on a study of functionality of given features of equipment and observation of the equipment in use. The findings in this study are essentially in accord with the more detailed comments on this subject in an earlier USDA publication (*8*).

Observation in the six schools indicated that the equipment available was one of the most important factors in determining work methods, which in turn influenced efficiency. Some managers showed considerable ingenuity in making their equipment do more in terms of quantity and type of output than it was originally de-

signed for. On the other hand, it was evident that the impulse for any change to a new type of equipment would have to come from the outside. This again points up the value of informational trips to newly constructed school kitchens in the area. Limiting oneself to past experience in the selection of new equipment and printed or hearsay information is not likely to lead to satisfactory results in the long run.

Storage Areas

The major requirement for the receiving area is that it provide adequate floorspace for holding incoming or outgoing items. A clipboard and platform scales for checking in supplies and hand or platform trucks for transporting goods should be available. The scale should be a portable floor model with a capacity of 400 pounds, and preferably ½-pound graduations. Case goods likely will be counted only and moved into the food storage area. However, fresh produce and other items received in variable weight units need to be weighed. Furthermore, cooks may wish to use the scales when checking out bulk supplies from the storeroom. On the other hand, in many operations, personnel are so familiar with quantities received and used that they prefer to rely on visual inspection.

Platform trucks in the receiving area should be of the heavy-duty type, with a metal frame and platform, rubber-tired, ball-bearing wheels of which two are swiveled, and a handle on the swivel end. Light handtrucks found as standard equipment in most kitchens are not adequate, since they are usually not built for the type of loads handled in the receiving area. Handtrucks for transport of goods in smaller quantities from the storage area to the kitchen can be the same as generally used in the kitchen. However, in that case, the heavier models are preferable, since it is difficult to exercise control in daily operations over which handtrucks are used for specific types of loads.

Shelving in the storeroom can be of wood or metal. It should be supported by uprights not more than 48 inches apart. Practical height for the upper shelf is approximately 7 feet. Lower shelves should be adjustable in heights, and the lowest shelf should be 36 inches from the floor to permit storage of bulk items on platforms below. Shelves should be securely braced against tipping and provide a minimum of 1-inch clearance from the wall for cleaning and air circulation.

Shelving is available in 12-, 18-, and 24-inch depths. The 18-inch depth appears to offer maximum usable space and permit easy control for most items if access is from one side only. (The 12- and 24-inch depths are better for small and large items, respectively). Where access was from two sides, two 18-inch shelves placed back to back were used to advantage in the schools observed. Clearance between the shelves should be at least 15 inches to accommodate stacking Nos. 2, 2½, 3, and 10 cans.

Aisle space in the storeroom for minimum access to shelving only should be 30 inches. For movement of portable platforms and handtrucks between rows of shelves, at least 42 inches of aisle space is needed. Figure 3 shows a dry food storage room, used at one of the schools, that lacked sufficient space below the shelves for storage of large items.

Containers for bulk storage of food items can be as large as 200-pound capacity, if they are equipped with casters or located permanently on dollies (*9*). Aluminum or stainless steel are preferred for such containers, and construction with coved corners is desirable for easier cleaning. The bulk containers should be clearly

BN 27312

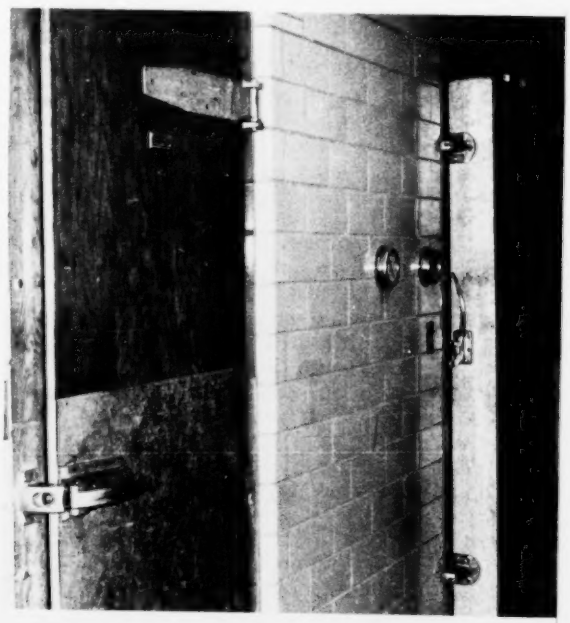
FIGURE 3.—A dry food storage room used at one of the schools studied.

marked as to contents, and each one should contain a separate scoop of corrosion-resistant material or other device to portion out the contents. To permit closer control of temperature in the dry food storage area, a thermometer should be placed where it can readily be observed. Direct entry and exit ventilation to the outside should be provided in the dry food storeroom. The storeroom need be heated only to prevent freezing of canned and bottled foods.

In the storage area for cleaning supplies, shelving of similar construction and dimensions as discussed previously is desirable. In addition, a metal or wood cabinet with hinged doors and a lock will be needed, to keep potentially harmful concentrations of cleaning agents from unauthorized use. Proper ventilation should be provided in this room. When it is used to store mops and other cleaning tools, a rack will be needed for their orderly storage. Hot and cold water should be available.

The refrigerated storage will require shelving that should be portable for easier cleaning and adjustable to varying storage requirements. Wooden shelves should not be used, because they are subject to mold growth. Stainless steel of the proper grade and type is necessary to assure that shelving will be sufficiently sturdy and will not corrode. A remote-reading type of thermometer and outside light switch with indicator light are necessary for proper control of temperature and light in the freezer and refrigeration section. Door construction is especially critical, since easy operation and proper insulation must be guaranteed. Figure 4 shows the functional arrangement of access to the refrigerated storage areas in one of the schools studied.

The overall specifications governing the construction of refrigerated areas and refrigeration equipment are highly technical. Only a person with the proper training can make the proper recommendations, which then should be expressed in detailed technical specifications.



BN-27315

FIGURE 4.—Access to refrigerated storage areas, featuring outside temperature and light indicators and well-insulated doors shielded against traffic damage.

Food Preparation

This discussion is divided into sections on the selection of cooking equipment, mechanical equipment, and other fixed and portable equipment. It points out the major features of equipment that will determine satisfactory operation, as well as labor requirements and effort in the overall operation of the facility.

Cooking Equipment — Ranges are the traditional heart of the cooking center. They come in sections 30 to 36 inches wide, with a cooking surface of 5 to 6 square feet per unit. Heavy-duty solid tops permit fuller utilization than open burner tops. Use of the solid tops as grills is possible on some models. Schools visited preferred ranges with ovens below rather than storage shelves. Even though these ovens are not as convenient as deck ovens, they represent overflow area when regular deck oven space is being used to capacity.

The cooking surface for ranges mounted on legs or masonry bases was found to be from 34 to 36 inches high. With a 36-inch height, small persons using stock pots with 10-inch walls had to use a small stepping stool to maintain a comfortable position while stirring food. This is not a satisfactory arrangement. Back shelves on ranges are convenient for temporary holding of ingredients or food, but they do not serve well to hold full pans of food since they are likely to be too high for safe lifting of hot pots and pans. For reasons enumerated in the discussion of steam cooking equipment, larger schools are turning more to steam cooking equipment. The largest school studied, feeding close to 2,000 students, had only two range units, which proved quite adequate since nearly all food was cooked in the higher capacity steam equipment. Management reported that one range top would have been sufficient.

Deep fryers are not a regular part of equipment needed for Type A meal preparation. However, they can be used to widen the variety of

food offered. They come in three basic sizes, with a fat capacity of from 10 to 15 pounds, 30 to 40 pounds, and 45 to 60 pounds. Their output of product per hour should be 1½ to 2 times the weight of fat. Operational techniques, such as blanching potatoes before frying them and partially cooking chickens or other items, will increase productive capacity of other equipment, and these factors must be evaluated in selecting the proper size. Range, grill, and deep-frying equipment used in an operation providing up to 2,000 meals per day are shown in figure 5.

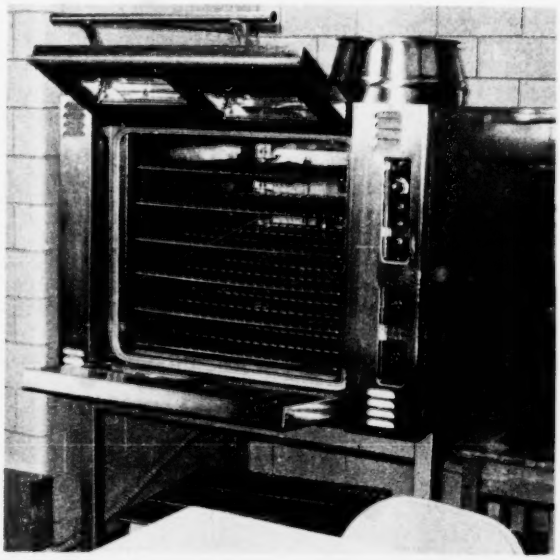
Ovens are available in single or multiple-deck types, with fixed or adjustable shelves. Automatic temperature control at each deck is desirable. Ovens should permit easy and thorough cleaning. Decks of ceramic material should be nonabsorbent and hard enough so they will not be injured in cleaning. In one of the schools studied, considerable extra time was expended after each use to keep an oven with a corrosion-prone inner lining in satisfactory condition.

Although roasting decks in stack ovens can be adapted for baking by the use of shelves, the trend in larger schools appears to be toward the use of convection-current baking ovens with adjustable shelving that permits better utilization of oven space (fig. 6). Glass doors and inside lights can save considerable labor time and result in a better oven performance because there is less need to open the doors to check the progress of the baking or roasting process.

Thickness of insulation, heat loss, B.t.u. input per hour, and type and strength of materials used in construction of ovens should be discussed with persons familiar with technical aspects, since these data can offer important indications of performance.

BN-27317

FIGURE 5.—Range, grill, and deep-frying equipment used in a school lunch operation providing up to 2,000 meals a day (major reliance upon steam cooking equipment).



BN-27309

FIGURE 6.—High-capacity, convection-current baking oven.

The choice of gas or electricity as a fuel for cooking equipment is largely one of local availability and preference. No generalization can be made about the most desirable choice. In the different schools studied, both types were used under very similar conditions, and personnel were equally well satisfied with the performance of both.

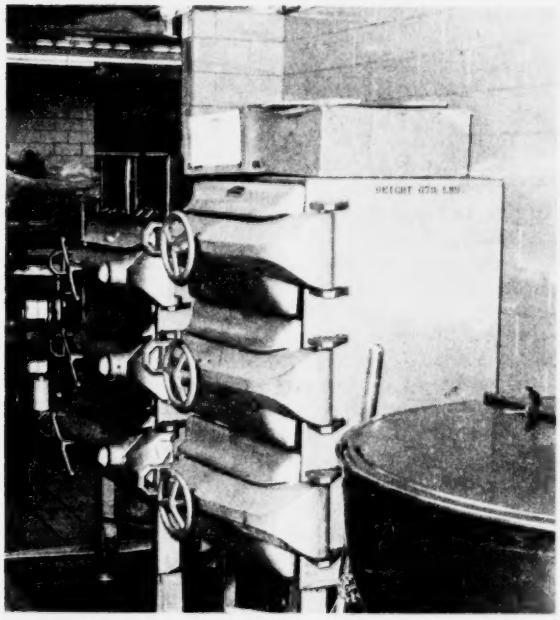
In selecting steam equipment for cooking, the source and character of the steam must be considered. Direct connection to the boiler supplying heat for the school is satisfactory only if a constant pressure is available during the entire school year. Needs of individual pieces of steam cooking equipment varies from 5 to 15 pounds per square inch of minimum pressure.

Use of compartment steamers for cooking has several advantages. Compared with range-top cooking, cooking time is reduced and capacity per square foot of cooking space is increased. Food does not need to be stirred during cooking, as in stock pots on the range top, and it can be served from the containers used for cooking. Consequently, appearance of the product is improved and energy required by cooks is reduced. On the other hand, some lunchroom supervisors with considerable experience insist that it is more difficult to maintain flavor of various foods during steam cooking, and they prefer to use range-top cooking.

Compartment steamers observed in school kitchens accommodated two to three regular steam table pans (12 by 20 inches) per deck and had no more than three compartments. Multiple units of this type were preferred to the larger commercial types of steam ovens, mainly for flexibility reasons (fig. 7). Compartment steamers of either stainless steel or galvanized steel have proven functionally satisfactory in school kitchens. Safety valves, air vents, safety locks on doors, and timer units are important features to examine in the selection process. An automatic timer is a desirable optional feature. Perforated and solid stainless steel baskets for cooking are available. The schools observed all used the regular steam table pans for cooking and thus had less pot handling and cleaning time than operations relying entirely on range-top cooking.

Steam-jacketed kettles were used extensively in the larger schools. The kettles observed were deep, two-thirds jacketed, and stationary, and they were equipped with a drawoff faucet. Stainless steel is the preferred material. A safety valve and pressure gage should be part of all steam equipment. Kettles with self-generated steam should have an automatic low-water cutout and a thermostatically controlled heat cutout.

Some schools use kettles with a capacity up to 100 gallons. For certain foods not subject to crushing by mass movement, and if a man is available to assist in stirring, this may be satisfactory. Ordinarily, however, 40- to 60-gallon kettles should be considered the maximum size for the preparation of foods requiring stirring. The shallow, full-jacketed kettle with less capacity and tilting mechanism may be easier for women cooks to handle.



BN-27320

FIGURE 7.—Compartment steamers and steam-jacketed kettle.

When steam kettles are being installed it is important to provide connections with hot and cold water and a swivel faucet for ease of filling and cleaning the kettles. Drawoff faucets on stationary kettles are of maximum value only if they are tangent to the bottom of the kettles, permit easy cleaning, and are protected from bumping by handtrucks. Suitable floor drainage in this area is important to prevent hazardous slipping on slick floors. The height of the rim of the kettles as installed will vary somewhat, depending upon the depth of the kettles, but a good average height is 36 inches. The rim should be reinforced to withstand wear. Covers of large kettles should be hinged, balanced to stand open without tipping, and easily removable.

A hood or canopy with filters and exhaust fans is needed over all cooking and baking equipment to draw off heat, steam, and cooking odors and to remove grease from the air. Best clearance of the canopy is from 5 to 6½ feet above the equipment, and about 2 inches of overhang for each foot above the equipment is needed to assure proper operation. Canopy hoods should have smooth surfaces free of crevices, trim, or other projections. Metal and masonry finishes have proven satisfactory. Sealed-in vaporproof lights should be installed as required for proper illumination of work areas. Switches for lights and fans should be away from the immediate cooking area.

Mechanical Equipment.—In smaller schools, reach-in refrigerators may meet the need for refrigerated storage space. But even in larger schools with an adequate walk-in refrigerator, the use of reach-in units closer to the work stations and the serving line is indicated. Institutional refrigerators are available with hinged or sliding doors, verminproof insulation, rotproof gaskets, and plated or stainless steel hardware. Porcelain enamel exteriors may be more subject to damage from bumping, but stainless steel exteriors will show fingerprints more easily. Doors on both sides of the refrigerator may be desirable if it is located behind serving lines or between two work stations.

Sinks should be provided at three locations. A small sink approximately 15 by 15 by 8 to 12 inches installed in the cook's table near the ranges is desirable. There should be a vegetable

preparation sink with two or more compartments of approximately 20 by 20 by 12 to 14 inches inside measurements. (A mechanical waste disposer should be installed in one of the sink compartments, if water and sewer conditions permit. Drainboards at least 24 inches in length, draining into the sink at a height of 34 to 36 inches from the floor, make work next to the sink possible.) A two- or three-compartment pot sink also is needed. Compartments in this sink should be at least 24 by 24 inches inside measurement, with a depth of 12 to 16 inches. The bottom of this sink should be at least 24 inches above the floor, with the front rim 36 to 40 inches above the floor. Observations indicated that where these measurements were reduced substantially, undesirable working conditions resulted. Apart from the utility sinks, a hand lavatory should be part of every kitchen operation. A standard-size sink, with a mixing faucet and soap and towel dispenser, will be sufficient.

Vegetable peelers vary in size from 15 to over 50 pounds capacity. In smaller schools where sink area is limited, the portable type may be moved away from the sink when not in use so that the sink may be used more conveniently for other purposes. In larger schools, a stationary installation adjacent to a sink is preferred. Models with 30-pound capacity usually will be large enough for school lunch operations, since eying of potatoes, rather than peeling, generally limits overall speed. It is desirable that peelers be equipped with automatic timers and a peel trap or integral waste disposer. If installation is permanent, the peeler must be high enough to discharge properly onto a drainboard or into a sink. Figure 8 shows a good peeler and sink arrangement in one of the schools studied, although in a different kitchen layout it may be desirable to locate the salad and pot sinks farther apart.

Food mixers used in school lunch operations vary in size from 20-quart bench models to 60-quart floor models. Since continued maximum use of the smaller models can easily lead to splashing and overworking of the motor, lunchroom supervisors point out that larger models (30 and 60 quart) are only moderately higher in first cost, have a stronger motor, and can still be used to advantage for the smaller tasks with the aid of adapter bowls. Larger models can be as versatile as the smaller ones, if they are provided with vegetable slicer, dicer, or meat and food chopper attachments. A bowl dolly will be required for the 60-quart size.

Separate food cutters are justified, since they perform a somewhat different task, and assure that the mixers will remain fully available for their primary purpose. An electric table model slicer with gravity or mechanical feed is needed in any size of school lunch operation. It should have a 10- to 12-inch knife, and an angle feed permitting proper drainage.

BN 27321

FIGURE 8.—Satisfactory arrangement of vegetable peeler, salad sink, and pot sink, with adequate drainboard space.

Tables for baking, cooking, and vegetable preparation should be adapted for their specific use. Working height should be adjustable in the 34- to 36-inch range. Drawers should be provided for storage of cutlery and other small equipment used, and should open toward both sides. Tables, if used from one side only, need not exceed 24 to 30 inches in width; if used from both sides, 42 to 48 inches is appropriate. Legs should be constructed so they will not interfere unduly with floor cleaning. Shelf space under the table top may be enclosed as a storage cabinet.

Both stainless steel and laminated maple strip table tops were observed; they performed equally well. However, attitude of local sanitation authorities toward the use of wooden table tops vary. If the wooden table top is not of superior material and workmanship, cracks can develop, which harbor bacteria impossible to remove by normal cleaning practices. National Sanitation Foundation Standard No. 2 for food service equipment does not take specific exception to wooden table tops, but several of the general paragraphs of this standard can easily be interpreted to make the use of such table tops unacceptable once they develop the slightest crack.

In the use of tables for specific tasks, baking tables with shelves in the rear offer special convenience. The base of baking tables should be

open to accommodate storage of portable bins for bulk ingredients (fig. 9). The cook's table may have an overhead utensil rack, but its height should be adjustable, since any standard height recommended in previous publications was considered either too high or too low by kitchen workers questioned on this matter. An open shelf below the cook's table will permit easy storage of pots, pans, and sheets. The base of the salad table should be enclosed, especially if it is used to store dishes.

Portable landing tables 2½ by 4 feet or smaller have multiple uses in school kitchens. Stainless steel construction, rubber bumper protection, and caster wheels of at least 5-inch diameter are likely to assure good performance. Four swivel wheels are preferable. Wheel locks should be specified if the tables are to be used for operation of mechanical equipment.

For smaller tasks, all-purpose utility trucks are needed. Average size is approximately 38 inches long, 22 inches wide, and 36 inches high, with two or three decks. In the selection of such trucks, gage of material, load capacity of the truck, size, type, and construction of wheels, and type and extent of bumper protection should be noted. The same general criteria apply in the selection of portable cooling or utensil racks. Rigid reinforced construction is essential in all such carts or trucks.

A fire extinguisher of an approved type and first aid kit belong in every school kitchen, and should be easily accessible.

BN-27319

FIGURE 9.—Baking table with rear shelves, bulk container below the table, and mixer to the left.

Serving Area

In addition to fixed serving counter installations, mobile serving counter sections were observed in use. In both, functionality of the equipment is highly important, because the speed and smoothness with which students are served are very important determinants of labor time and efficiency.

In nearly all schools, serving counters are constructed of stainless steel. The length of the counter may vary from 15 feet to 20 feet, depending upon the type and number of sections. At the beginning of the line, room must be provided for a tray section, either as an integral part of the counter or in form of a portable cart or platform. This will require up to 2 feet. The silverware section may be located next, taking another 1½ to 2 feet of counter space, or it may be located at the exit end of the counter. In some installations, silverware is displayed on a separate table, away from the serving line.

The hot food section should have at least four rectangular openings to accommodate standard 12- by 20-inch pans of different depths, or a combination of smaller pans with the aid of pan adapter bars. Dry heat should be provided, and a separate, easily accessible heat control for each pan space is desirable. Schools with only three openings in the hot food section of their main serving line reported that a fourth pan opening is needed. In two schools, an 8-inch-wide drop shelf had been attached to the cooks' side of the hot food section, permitting the cooks to slide plates along the counter when serving hot food. At other times the hinged shelf was lowered, so it would not interfere with traffic behind the serving counter. A cutting board insert on the serving side of the counter, extending no more than 4 inches beyond the serving face of the counter, will fulfill the same purpose. The warming table requires from 6 to 8 feet of the length of the serving counter.

The cold food section is used for display and self-service of bread, salads, fruits, and desserts. A plain counter top with elevated shelves is sufficient. This requires another 6 feet of the length of the serving counter. The entire length of the hot and cold food sections should be protected from airborne bacteria by a vertical or slanted sneeze guard. A landing shelf over the guard is desirable, but a reach-through space under the guard also is needed, especially if elementary school children are served, or if self-service in the cold food section is intended. The guards may be hinged for easy cleaning, and should be vented below the upper shelves to prevent steaming.

Some serving counters have an integral milk cooler section for individual 8-ounce containers,

BN-27314

FIGURE 10.—Serving line, showing food warmer with cutting board insert, sneeze guard extending over hot and cold food sections, milk cooler section, and cashier's section. Menu is being posted on the board.

with an automatic lowerator (a device that automatically raises as the top containers are removed to expose supplies stored beneath) permitting uninterrupted self-service. Other counters merely provide a space into which a separate milk cooler can be placed. In still other schools, the milk cooler is placed adjacent to the serving line. If so placed that supervision can be exercised by serving line personnel, and if the flow of traffic in the line is not held up, this also is an acceptable solution. Bulk milk dispensers, preferably with an automatic measuring device, are available, but their use in school lunch operations was not observed in this study.

Ice cream cabinets in nearly all of the schools observed were the property of the dairy company. If mounted on wheels, these self-contained units can be placed anywhere adjacent to the serving line where an electrical outlet is available.

The cashier's section requires another 2 feet of the serving line. It should be equipped with a locked cash drawer and a mechanical counter for the accumulation of five separate totals, or a small cash register with the appropriate number of coding keys. A stool is needed for the cashier, and a foot rest may be needed. Knee space under the counter should be provided.

The working surface of the serving counter should be approximately 34 inches high, and 28 to 30 inches wide. The tray rail should be of metal and should offer a solid surface approximately 12 inches wide. Height of the tray rail must be geared to the average size of the students. Tray rails about 28 inches high have proved adequate for elementary schools; in high schools they may be 32 to 34 inches high. Figure 10 shows the kitchen side of a modern serving counter.

Tables behind the serving line, pass-through refrigerators, menu boards, and other auxiliary equipment have proved labor-saving in many situations, but may not be necessary in all school lunch operations. However, it appears that any school lunch operation serving more

than 500 students and offering some food items for sale in addition to the Type A meals will have reasons to consider their use.

Dishwashing Area

Single tank, stationary-rack, door-type dishwashing machines were observed in kitchens serving up to 500 meals per day. This included kitchens in which divided trays were used, as well as individual dishes. Two-tank conveyor-type machines were observed handling loads up to 1,800 student meals a day. This also included kitchens serving food on both individual dishes and divided trays. In larger kitchens, selection of a dishwasher with a continuous-racking conveyor may be advantageous.

Proper sizing of dishwashing machines depends upon the number of student meals, the number of individual dishes, the total dish supply at the school, hours of operation, and the general layout of the dishwashing area. Regardless of size and type of machine, however, lunchroom personnel in all the schools visited found it necessary to rinse dishes before putting them through the washer. This can be accomplished most rapidly if the rinsing unit is combined with the scraping and food disposal station. A rinsing brush should be attached to the water supply. Use of a self-feeding food waste disposer with 1½-horsepower motor is likely to assure continued flow of operations.

Inspection and cleanout doors and automatic detergent feeders and wetting agent injectors in the final rinse water aid in efficient operation of dishwashers. None of the schools visited had difficulty in maintaining the 140° F. wash-water temperature, but a booster heater is needed to assure the desired 180° to 190° rinse-water temperature. Dish and tableware racks are needed in sizes suitable for the machine. They should be of corrosion-resistant material, and relatively lightweight.

Fixed tables for dishes should have stainless steel tops, 24 to 36 inches wide, with rolled edges; they should drain toward disposal sink and dishwashing machine. Space underneath the tables is profitably used for shelves to store dish racks. Length of tables varies with size of operation, but a minimum of 6 feet is needed to permit deposit of dirty dishes, scraping, rinsing, and stacking into racks. At the exit side of the dishwasher, there should be space for air-drying dishes in five racks. The exit table should be at least 9 feet long.

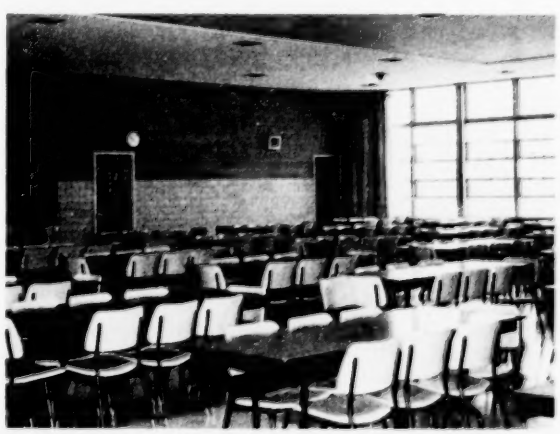
Handtrucks for transporting clean dishes to the serving area and for storing dishes under the serving counter, salad table, or elsewhere, are the same ones used for other purposes in the kitchens. Other carts for permanent storage of dishes may be used to eliminate extra handling.

Lunchroom

The types of tables and chairs selected will vary with the other purposes for which the lunchroom is used. Folding or in-wall tables with benches attached are desirable for multipurpose use of the room and for elementary school students. Dollies for moving and storing tables will be needed if they are not part of the folding construction. Folding tables with attached benches and integral wheel construction permit a janitor to clear and sweep an elementary school lunchroom with 250 seats (for dual use as a gymnasium) within 15 minutes.

Chairs rather than benches are preferred for junior and senior high school students. Chair construction should conform to good posture requirements and be sturdy to withstand daily use. Attention should be paid to leg construction and type of casters in relation to flooring material, to assure easy and safe moving of chairs without making undesirable marks on the floor. Portable racks for chair storage are a help during major cleanup operations. Figure 11 shows a modern lunchroom in a high school. Use of separate tables and chairs and selection of colors helped greatly to create a pleasant atmosphere in this lunchroom.

A water fountain with a protected angle-jet might be stationed near the doors. Height should vary from 24 inches for primary grades to 36 inches for upper grades. Racks and shelves for coats and books may or may not be needed, depending upon local practices and other uses for the room.



BN-27316

FIGURE 11.—Modern lunchroom in a high school.

Office and Employee Facilities

Head cooks and lunchroom supervisors should each be provided with a desk, chair, and filing cabinet. In larger schools, an adding machine or desk calculator in the kitchen office can eliminate the need for frequent trips to the main school office. Connection to the intercom system of the school, if one is available, also is desirable. A telephone is necessary.

The locker room should provide a separate closet space with lock for each employee. Toilet facilities and lavatory are mandatory. Inadequate facilities in one school studied were believed to have had an adverse effect upon employee morale. A cot and shower facilities are optional.

Location of Equipment and Layout of Individual Work Stations

In the section on basic concepts of layout, straight-line flow of work was cited as the major objective in locating general service and production areas of a school lunch operation. This holds true in arranging work stations within the kitchen too. Placement of equipment in the kitchen and serving area is also governed by a second consideration. The quantities and the variety of products made in school kitchens require that the layout within the kitchen be organized into individual work stations along functional lines. Products made in the various sections (such as salad, cooking, and bakery) are quite different and usually cannot be processed on an assembly line or straight-flow plan, because different equipment is required in each section. As a result, it may be more advantageous, especially in small school kitchens, to have a certain amount of additional movement to make fuller use of one specific piece of equipment (such as mixer) rather than have several similar pieces of equipment. In larger operations where equipment is used more nearly to capacity, there will be more justification to duplicate equipment and to adhere more closely to the concept of straight-line flow of work.

Economy-of-scale considerations and the desire for maximum equipment utilization make placement of equipment in functional clusters important (for example, vegetable peeler and salad sink and table together in one central location). But as indicated earlier, these equipment clusters or work stations must be located in relation to each other to minimize walking distance and movement of materials.

A number of analytical techniques for evaluating the effectiveness of different layouts and locations of work stations can be used to advantage. One of them is a distance chart. It consists of a scale drawing of the kitchen facility on graph paper, on which ¼ inch on paper generally represents 1 foot of distance in the kitchen. This distance chart should be used in combination with a sequence or flow process chart. On the flow process chart are listed in logical order the steps that have to be completed in preparing individual foods, together with the locations and equipment used for each process.

In evaluating present and future placement of equipment and work stations, one should take different floor plans and measure the distance that must be covered in each layout when performing a given series of tasks; for example, the conversion of frozen hamburger into cooked hamburger. Listing total distances, number of individual movements, and other pertinent factors will not automatically answer the questions about which layout is better. But it will help considerably in making a decision, in that those factors that can be quantified are expressed in numbers, leaving the lunchroom supervisor free to devote more thought to the nonquantitative aspects of the problem. In the planning and evaluating of layouts for large school kitchens, it may be worthwhile to apply even more detailed methods of layout analysis, as discussed in literature on food service planning.

Just as the selection of individual pieces of equipment must consider overall balance in capacity, layout within the kitchen must strive for the maintenance of balance and the avoidance of bottlenecks in production and traffic. This is often neglected in space allowances for major traffic aisles. Aisle space should permit free, easy movement of essential traffic. The minimum width for a lane between equipment where one person works alone is 36 inches. Where more than one person is employed or mobile equipment is used, a minimum of 48 inches is recommended. Where workers are likely to pass each other regularly with mobile equipment (such as the access to the dry storage area) 60 inches is needed.

Providing adequate aisle space usually means that only ⅓ of total floor area in the kitchen should be covered by equipment, with about ⅔ devoted to work areas, traffic lanes, and space around equipment for easy operation and cleaning. This guideline may appear unnecessarily stringent to many local school officials, but this study clearly indicated the importance of this point. Only those kitchen layouts in which floor covered by equipment did not significantly exceed the above figure could be considered adequate for traffic flow as well as safety and sanitation. How seriously a significant departure from these values can affect the situation (especially in smaller schools) was evident in a layout

in which equipment, due to lack of space for expansion, covered nearly 50 percent of the floorspace. In this kitchen, the flow of traffic was so hampered that 30 percent more labor time per meal was required than in another kitchen feeding a similar number of students but having more floorspace. Under such conditions, savings in the first cost of providing space for the kitchen are quickly dissipated by additional operating expenditures, with concurrent inconvenience and adverse effect on overall efficiency of kitchen personnel.

With the basic principles of straight-line and functional flow of work in mind, layouts in the school kitchens observed were evaluated and discussed with the respective lunchroom supervisors and head cooks. This led to the following general conclusions.

Work Centers

Table space for main dish preparation should be located centrally, close to dry food storage and refrigeration areas. Tables 8 to 10 feet long should be used if two people are expected to work side by side without interference. Where workers work opposite each other, a table up to 42 inches wide is needed. A small sink at one end of the cook's table is desirable, but not necessary if distance to the pot or salad sink is not too great. More definite savings in labor time can be achieved with a pot rack above the cook's table, drawers for storage of small utensils, and shelves below the table for the storage of pots and pans.

The space between the cook's table and the cooking center should not be a major thoroughfare. The food mixer with attachments or separate food cutter and slicer are properly located adjacent to the cook's table, since this is the work area where they will be used most often.

General location of the baking table is more flexible. If bulk storage containers for flour and other ingredients are kept below the bake table, this can be the work center farthest removed from the food storage room. Since extensive working space is needed for baking, separate tables (usually 6 feet long) are used if more than one worker is expected to prepare baked goods at a given time.

Easy access to the mixer is important. In medium and large kitchens, a separate food mixer usually is located next to the baking tables. Also, if distance to the walk-in refrigerator is considerable, a small reach-in refrigerator should be within a few feet. Use of portable racks holding six or more standard-size baking sheets reduces the need for a portable landing table, and makes placement of the baking tables away from the ovens more acceptable. Portable cooling racks can be used both for loading ovens and for cooling the product.

The center-island type of cooking and baking area appears to be preferred, although installations along a wall also were observed. Neither type appears to have a decided advantage in labor time and effort. Ranges and steam equipment usually are placed together, whereas ovens, to the extent that the venting problem can be solved, may be placed somewhere else. It is highly important, however, that landing space is provided for hot pots, pans, or sheets taken from the ranges or ovens. Portable landing tables or the cook's table will suffice, if the distance is not more than a few steps.

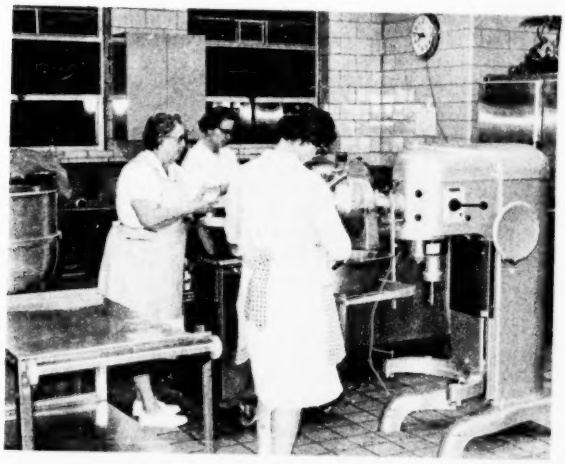
The sink for cleaning pots and pans, consisting of three compartments, should not be far from the cooking center. Preferably, it should be possible to reach the sink without having to cross the major traffic lane. At least 4 feet of drainboard is needed adjacent to this sink, if possible on both sides of the sink. Use of handtrucks to hold dirty pots and pans temporarily, especially if they have to be soaked, is not a satisfactory solution.

Use of a bacterial sanitizing agent in the third compartment of the sink is indicated, unless this compartment is equipped with an immersion heater keeping the temperature of the rinsing water at 180° F. Otherwise, the pots and pans will have to be sent through the automatic dishwasher for a final sanitizing rinse.

Best location for the vegetable peeler is adjacent to a sink, somewhere along the straight line of flow between the storage area and the cooking center. Placement directly adjacent to the cook's table or the baking table is not desirable because of splashing and odor. A waste disposer in the sink or as part of the peeler helps keep the area clean.

Large school kitchens usually have a separate salad sink. If it has at least 4 feet of drainboard space on each side, this can be used as a work station. If salads are served on individual plates, a separate salad preparation table is less tiring to use. If the table is not close to the walk-in refrigerator, a separate reach-in refrigerator should be located near it. If salad plates are prepared individually, location of the salad table adjacent to the serving lines and use of a reach-through refrigerator will save labor by reducing travel of the finished product. Efficient use of portable landing tables near the mixer in salad preparation is shown in figure 12.

Location of the bread, butter, and sandwich preparation area is more flexible. In smaller schools, the salad preparation table can be used for this, especially if the bread as delivered is kept on a portable rack. In large schools featuring different types of sandwiches in addition to



BN-27310

FIGURE 12.—Use of portable tables and mixer attachments in salad preparation.

hot plate lunches, a separate table is indicated. The finished product may be held in a portable rack until it is placed on the serving counter.

Serving Lines

The serving lines, if located in a separate room, should be adjacent to the kitchen. They also should be located so that they can be closed off from the lunchroom if that room is used for other purposes. If the serving lines are part of the kitchen, the view into the kitchen can be blocked by refrigerators and tables with back shelves, placed so they do not impede traffic between the kitchen and serving area. Having the serving line close to the kitchen minimizes the distance that hot food must be transported. It also permits better labor utilization within the kitchen. Scheduling of students through the serving line often will result in a flexible demand for kitchen personnel at the serving line. On the other hand, many small tasks to be done in the kitchen during the serving hours can be handled efficiently by serving line personnel only if they do not have to walk a great distance to the kitchen.

Both straight-line and L-shaped serving-line layouts were observed in operation. In speed of serving students, the shape of the serving line apparently is less important than the scheduling of grades through the serving line and student discipline. Movement of the students through the serving line from right to left or vice versa did not appear to affect the efficiency of serving operations.

Whether the hot food section should be located closer to the beginning or the end of the line is a question on which lunchroom supervisors did not agree. If the serving line moves at a desirable pace of 6 to 8 students per minute, the time involved should not affect temperature of the food significantly.

Dishwashing

Dishwashing layouts should be adjacent to the lunchroom so that soiled dishes can be returned by students directly through a window. If this is not the case, extra personnel will be needed to collect the dishes in the lunchroom and transport them to the dishwashing area. Installation of a continuous belt from the lunchroom to the dishwashing area is not justified in most school facilities.

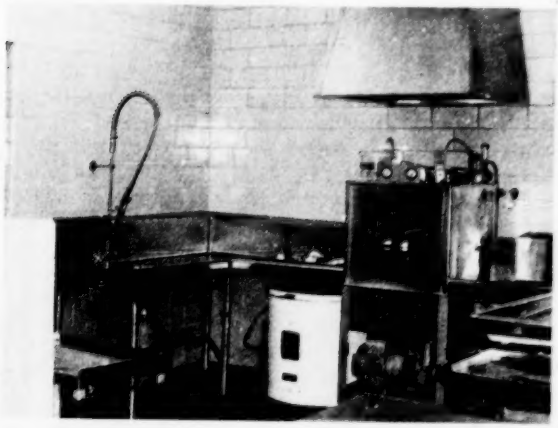
Inasmuch as dishwashing practices vary (depending upon the use of trays or dishes, prewash rinsing of individual dishes or racks, and immediate removal of clean dishes from the area), the most suitable dishwashing layout also will vary. If a food waste disposer is available, and prewash rinsing of individual trays and dishes is desired, these two functions can be combined.

A space of approximately 2 feet for loading the racks must be provided between the sink (with food waste disposer) for rinsing the dishes and the dishwasher itself. If rinsing of the loaded rack is considered sufficient, several persons might scrape the residues into a trough along the table, and water in the trough would flush the residues into the automatic disposer. In this case, the sink for rinsing is best placed directly in front of the entrance to the dishwashing machine.

Exit space from the dishwasher should permit room for straight forward movement of at least three racks, so that a temporary interruption of the removal of clean dishes will not stop the flow of the operation. Room for five racks is recommended, so that dishes can air-dry before they are returned to the serving line or stored. The dishwashing tables should permit storage of empty racks on shelves below. Figures 13 and 14 show good dishwashing layouts observed in the study.

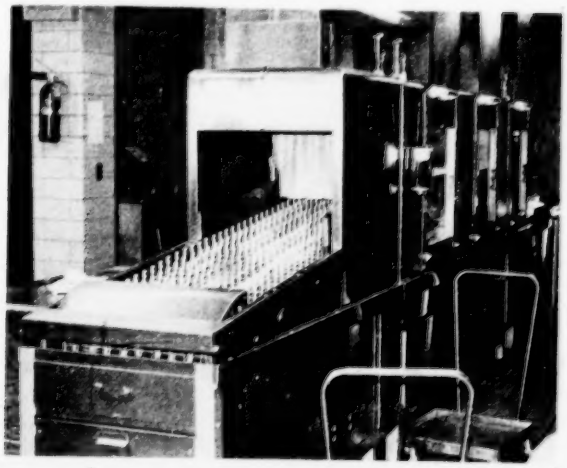
The continuous-racking type of dishwasher for use in large school kitchens requires more straight-line room for the installation of the machine itself, but only a portable landing table is needed at the exit end. Thus, total space required for the entire dishwashing layout is not significantly different from that needed for the installation of a smaller machine with auxiliary tables.

Sufficient space should be provided at the end of the dishwashing machine to permit free movement of two or more handtrucks for re-



BN-27311

FIGURE 13.—A small-scale dishwasher layout, featuring sink (for prewash rinsing) with waste disposer, single-tank door-type dishwasher with automatic wetting agent injector, and booster.



BN-27318

FIGURE 14.—Continuous-racking automatic dishwasher in a school kitchen providing up to 2,000 meals a day.

moval of clean dishes. Use of handtrucks, portable racks, and other mobile equipment adds considerably to the flexibility of overall operations. For this reason, it must be stressed that adequate aisle space for such mobile equipment is not wasted space. Adequate aisle space and extensive use of mobile equipment provide assurance that the most will be realized from the total investment in facilities and equipment. This will also assure better labor utilization.

OBSERVATIONS IN THREE SIZES OF SCHOOL LUNCH KITCHENS

In cooperation with the Chief of the Ohio State Public School Lunch Program, nine schools were selected as having above-average kitchen facilities and as using recommended practices in the preparation of school lunches. Three schools were selected in each of the following size groups: Those serving from 350 to 500 lunches daily; those serving from 700 to 1,000 lunches daily; and those serving from 1,400 to 2,000 lunches daily.

Each of the nine schools was visited to determine the type of facilities, equipment, layout, and number of personnel, and the average number of meals served during the month before the visit. Based on the visits and recommendations of the Chief of the Ohio School Lunch Program, six schools were selected (two in each of the three size groups) for 1 week of intensive study.

One of the major purposes of this study was to develop, by reliable methods, a breakdown of total labor time expended in kitchen operations of various sizes and layouts. Since, even within the same kitchen, labor time will vary with the menu served, the six schools studied were asked to use the following menu during the week of observations.

Menu served at each school during the week of observations

Day	
Monday	Spaghetti/Meat Sauce Tossed Green Salad Pear Half French Bread and Butter Milk
Tuesday	Creamed Turkey on Biscuit Buttered Broccoli Cherry Crisp Biscuit and Butter Milk
Wednesday	Hamburger Patty on Bun Buttered Potatoes and Peas Tomato Slice Peach Upside-Down Cake Milk
Thursday	Beef Stew Molded Fruit Salad Cornbread and Butter Milk
Friday	Baked Fish/Tartare Sauce or Cheese Meat Loaf Buttered Green Beans Cabbage and Green Pepper Slaw Rolled Wheat Cookie Hot Roll and Butter Milk

Use of the menu facilitated a uniform comparison of observations. The menu was selected to include meals generally served in all schools in the area and to make use of the kinds of equipment found in most school kitchens. Observations in each school extended over a full week, to include every situation usually encountered in operations; and extensive notes were taken on work methods, equipment used, and unusual occurrences. Observations in each school for the 5 days were averaged to obtain figures that would be representative for Type A hot plate lunches in general, rather than for specific types of meals. (Time requirements for a given day and a particular meal varied by as much as plus or minus 14 percent from the averages.)

Characteristics of Schools Studied

Schools selected for study are all located in Ohio. They are designated in this report by the letters A through F. School A is an elementary school that was 2 years old at the time of the study. Its kitchen, serving line, and dishwashing areas occupied 900 square feet with 35 percent of the floorspace occupied by equipment. During the study an average of 368 meals were served per day. The school had a very good kitchen layout with 200 square feet of dry storage space and 60 square feet of nonfood storage space. The kitchen had good equipment and was designed for preparation of 400 meals a day.

School B is also an elementary school, built in 1955. The kitchen was designed to prepare 200 meals per day, but during the study an average of 400 meals a day was served. The kitchen occupied an area of 480 square feet with nearly 50 percent of the floor occupied by equipment. While the kitchen layout was good, it was crowded and lacked sufficient oven space. Only 80 square feet of storage space was available.

School C is an elementary school. An average of 663 meals were served during the study. The school was built in 1958, and the kitchen was designed to serve 700 meals a day. The kitchen, serving lines, and dishwashing areas occupied 1,800 square feet of floorspace. Two additional rooms, with an area of 20 square feet each, were available for storage. The kitchen was adequately equipped except that additional refrigeration and freezer storage space was needed. Equipment occupied approximately 30 percent of the floor area.

School D is a high school. An average of 702 meals were served during the study. The kitchen, built in 1955, occupied an area of 950 square feet. Nearly 50 percent of the floor area was occupied by equipment. Adequate storage space was provided in two rooms occupying 180 square feet and 160 square feet, respectively. Sufficient functional kitchen equipment was provided.

School E is a high school built in 1958. During the study an average of 1,837 lunches were served per day, including an average of 766 meals shipped out by truck to three elementary schools. The kitchen occupied an area of 1,800 square feet, and about 30 percent of the floorspace was occupied by equipment. The kitchen equipment was modern and functional, and of adequate capacity; it included a commercial-size flight-type dishwasher. The layout was very good, except that less than 600 square feet was available in three different rooms for storage.

School F is a combination junior and senior high school built in 1954. Kitchen facilities were designed to prepare 1,200 lunches a day. During the study an average of 1,621 lunches were served per day. The kitchen occupied an area of 800 square feet, and approximately 45 percent of the floorspace was covered with equipment. There was sufficient equipment in the kitchen, although equipment was used to capacity. A total of 100 square feet of storage space was divided into two rooms, with an additional 400 square feet in the basement of an adjacent building. The kitchen layout was not very good because of the long, narrow design and inadequate floorspace.

Labor Requirements in Schools Studied

Labor required in the preparation, serving, and other activities associated with the meals, shown in the menu (p. 23), was determined by a technique known as work sampling (*3*). Depending upon the number of kitchen workers, between 2,500 and 5,400 individual observations were made of kitchen personnel at random time intervals at each school. On the assumption that the percentage of observations in each task category would be proportional to the time spent on that task, the breakdown of total labor time shown in table 1 was obtained.

Results are reported in table 1 in man-minutes of labor time per meal. While this unit measurement must be multiplied by the number of meals served at a given school to get total labor time, it is the only unit of measurement that permits direct comparison of data from kitchen operations feeding different numbers of students and having somewhat different work practices.

The data shown in table 1 include the labor time of all workers whose efforts could be directly allocated to school lunch operations. Labor time of persons contributing their time to a specific kitchen operation only intermittently was prorated. This means, for example, that only the appropriate share of time spent

TABLE 1.—*Time required to prepare and serve lunches in 6 Ohio schools.*

[Man-minutes per meal]

Activity	350–500 meals per day			700–1,000 meals per day			1,400–2,000 meals per day			Average 6 Schools
	School A	School B	Average	School C	School D	Average	School E	School F	Average	
Getting ready:										
Receive goods and move into storage	0.08	0.06	0.07	0.04	0.10	0.07	0.07	0.09	0.08	0.07
Maintain storage and move goods out	.07	.09	.08	.09	.21	.15	.12	.13	.12	.12
Setup and cleanup work stations	.18	.30	.24	.17	.26	.22	.20	.17	.19	.22
TOTAL	.33	.45	.39	.30	.57	.44	.39	.39	.39	.41
Food preparation and cooking:										
Prepare for cooking	.34	.79	.57	.47	.64	.56	.42	.53	.48	.53
Prepare for baking	.31	.35	.33	.33	.37	.35	.18	.36	.27	.32
Prepare salads	.25	.30	.27	.17	.31	.24	.10	.13	.11	.21
Prepare breads, etc.	.17	.17	.17	.09	.03	.06	.04	.17	.10	.11
Cooking and baking	.22	.32	.27	.22	.27	.24	.21	.27	.24	.25
TOTAL	1.29	1.93	1.61	1.28	1.62	1.45	.95	1.46	1.20	1.42
Serving of food:										
Setup serving line	.13	.22	.17	.28	.47	.37	.64	.53	.58	.38
Serving food	.93	2.15	1.54	1.27	.33	.80	.31	.17	.24	.86
TOTAL	1.06	2.37	1.71	1.55	.80	1.17	.95	.70	.82	1.24
Cleanup activities:										
Wash dishes and pots	1.27	1.04	1.15	1.04	.78	.91	.79	.98	.89	.98
General cleanup	.52	.67	.60	.71	.64	.67	.62	.73	.68	.65
TOTAL	1.79	1.71	1.75	1.75	1.42	1.58	1.41	1.71	1.57	1.63
Incidental activities:										
Administration and planning	.35	.37	.36	.43	.41	.42	.54	.52	.53	.44
Delays	.16	.08	.12	.42	.04	.23	.37	.46	.42	.26
Personal needs	.06	.05	.06	.06	.05	.06	.05	.06	.05	.06
TOTAL	.57	.50	.54	.91	.50	.71	.96	1.04	1.00	.76
TOTAL TIME	5.04	6.96	6.00	5.79	4.91	5.35	4.66	5.30	4.98	5.46

by the lunchroom supervisor on matters related to the specific kitchen operation studied was included under the category "Administration and Planning." Similarly, if the custodian regularly performed a job (such as the daily cleaning of the lunchroom) that in other schools was done by the female kitchen workers, the appropriate share of his time was included under "General Cleanup." A third situation that occurred frequently was the use of student help in the kitchen. Student labor time also was included under the appropriate task category, like "Dishwashing" or "Serving," since in other schools these jobs were performed by paid workers.

Total Labor Time

When the labor time of all people contributing to the production of the meals was included, it was found that an average of 5.46 man-minutes was needed to prepare and serve a meal for one person. This is equivalent to an average of about 11 meals per man-hour. The range observed in the six schools extended from 4.66 man-minutes per meal in school E (12.9 meals per man-hour) to 6.96 man-minutes per meal in school B (8.6 meals per man-hour). These data indicate a somewhat greater use of labor, or lower output per worker per hour, than the average output of 12 to 14 lunches per worker per hour considered normal by many lunchroom supervisors. The main reason for this difference is that lunchroom supervisors generally do not include their own time or that of the janitor when making their calculations.

The variation in labor requirements among the six schools was analyzed in regard to differences in total size of operations, layout of physical facilities, availability of equipment, and management and work practices. However, no one of these characteristics appears to have a sufficiently strong influence upon all components of total labor time that it could be ranked more important than the others. But when labor time needed for the completion of specific tasks was compared it became quite evident that certain factors (such as physical layout or management practices) can have an overriding effect on the time needed for a given task. The fact that school B, serving 400 students a day, had the highest labor requirements, and that school E with over 1,800 meals a day had the lowest labor requirements appeared to be a coincidence. Second lowest in labor requirements was school D, serving 702 meals a day, and second highest was school C, serving 663 meals a day.

Getting Ready for Meal Preparation

Receiving goods, maintaining the storage room, and setting up work stations took an average of 0.41 man-minute per meal, or 7.3 percent of total labor time. Considering the many different activities included in this category, this is a relatively small part of the total effort. Variations encountered among the schools ranged from 0.33 to 0.57 man-minute per meal.

Receiving and moving foods and supplies into storage took an average of 0.07 man-minute. This activity included unloading, checking, and storing incoming shipments. Products were moved into storage on 4-wheel handtrucks, and appropriate records were kept for each receiving. Daily deliveries were usually received and handled by the women kitchen workers. Only large shipments of canned goods or USDA-donated commodities arriving in bulk required the assistance of the janitor or some other male helper. Lowest labor requirement observed for this task was 0.04 man-minute, due primarily to the fact that no large shipment of staple foods was received at that school during the week of observation. The highest figure, 0.10 man-minute, involved a school in which the storeroom for staple foods was not directly accessible from the receiving area. In other schools, labor requirements for receiving goods were kept low because produce, milk, and bread were placed in the storage area or at their place of use by the delivery truck drivers.

Maintaining storage areas and moving goods out of storage for use took an average of 0.12 man-minute, with a range from 0.07 to 0.21. The time for this work appears to be heavily influenced by the size of the storage area and its distance from the kitchen. The 0.07 figure was observed in school A where the storage room is directly adjacent to the kitchen and 0.5 square feet of storage floorspace is provided per meal. The high figure of 0.21 was the result of inadequate room in the storage area next to the kitchen. Even though two other areas had been pressed into service and offered enough room, the need for daily restocking the kitchen storeroom from the other areas added to labor requirements. Furthermore, in the more crowded storerooms, extra time was needed to keep the shelves arranged.

Setting up and cleaning up work stations took by far the greatest part of the time needed to get ready for meal preparation. This activity includes time spent assembling equipment and machinery, and removing these items from the work station for later cleaning. It also covers walking from one work station to another, and

washing hands when changing jobs. The 0.22 man-minute required for these activities represents from 3 to 4 percent of total labor time in the lunchroom operation. The observed range from 0.17 to 0.30 man-minute reflects primarily differences in the storage location of equipment, aisle space between work stations, and workers' planning of the job. Use of a pot rack over the cook's table and availability of table drawers for the storage of small hand tools help to keep this segment of labor requirements down. Availability of adequate pot sink and drainboard space also is important, in that it permits soaking pans and equipment until enough of them have accumulated to make pot-washing worthwhile.

Preparation and Cooking of Food

All types of food preparation and the cooking and baking took, on the average, 1.42 man-minutes or 25.8 percent of the labor effort per meal prepared. Many different activities are included in this category and are subject to the same major influences—layout and location of work stations, methods of operation, and equipment availability.

A major factor beyond the control of local operations that influences time requirements for the preparation and cooking of meals is the size of operations. Data on the different schools indicate that larger batches of food and higher capacity of equipment in larger schools tend to reduce labor requirements per meal in food preparation. In school E, the largest operation observed, only 0.95 man-minute of labor for food preparation and cooking activities was required, whereas in school B more than 1.9 man-minutes were needed for the same output.

Food was prepared in the cooking department in an average of 0.53 man-minute per meal. The range was from 0.34 in school A to 0.79 man-minute in school B. In school A the cook's table, mixer, slicer, and other equipment needed are compactly arranged. The largest kitchen, school E, achieved nearly the same effect through the use of portable landing tables for food preparation; these tables were positioned adjacent to the mixer and other equipment needed, as shown in figure 12. The high figure in school B's kitchen resulted from placement of the work station in front of the cook's table, which required frequent stepping aside for passing traffic. Inadequate table space and low height of the working surface (32 inches) may also have adversely affected labor requirements in this kitchen.

In terms of labor practices, small kitchens have some disadvantages. Often the food cutter, shredder, or other attachments for the mixer are not available; or if they are available, the only mixer in the kitchen may be in use when needed. At other times, the small quantity of cutting or chopping to be done may not make it worthwhile to assemble the equipment. As a result, the job is performed by hand, and labor requirements are increased. Availability of separate equipment for preparations in the cooking department will help keep labor requirements even in smaller kitchens at a low level.

Preparation for baking required an average of 0.32 man-minute per meal. The highest figure was 0.37 in school D and the lowest was 0.18 in school E, where biscuits were not baked for the Tuesday menu. The main reason for similar labor requirements among the schools appears to be that methods used by individuals in baking preparation are more uniform than for preparation for cooking. Usually, a separate table located away from traffic is provided. Use of bulk containers under the baking table for flour, sugar, and other frequently needed ingredients helps to keep baking preparation time down.

Average time needed for salad preparation was 0.21 man-minute. Variation observed was high, ranging from 0.10 in school E to 0.31 in school D. This activity was defined to include the preparation of all foods that need not be cooked, such as fresh salads, and the opening of canned fruit to be served as dessert. The high variation observed in the preparation of salads appeared to be due to differences in methods and use of equipment. For instance, not all operations included the same number or amounts of different fresh vegetables in the tossed salad. Also, in two of the schools, the cabbage and green pepper slaw was chopped by hand rather than with a mechanical shredder. Finally, some of the schools served their salad on separate saucers; others kept it in a large container and served directly onto divided trays. Use of many different ingredients in the tossed salad improved the taste, but increased labor requirements. Serving salads on individual saucers increased the appeal of the meal to the student, but this practice also tended to increase labor time. On the other hand, use of mechanical food cutters and shredders helps reduce the time needed. The same can be said for the use of electrical can openers when preparing canned fruit for serving.

Although the average time needed for the preparation of bread and butter amounted to only 0.11 man-minute, the variation from a low of 0.03 in school D to a high of 0.17 man-minute in schools A, B, and F was striking. This difference was due again to the varying methods

used. Schools with the higher labor buttered bread and buns in the kitchen. Schools D and E served bread and butter separately, using portion-controlled butter patties. Those who buttered by hand reduced the time required by whipping the butter with a mixer before spreading it. Another labor-saving practice observed was the slicing of several loaves of french bread at the same time, rather than running each loaf separately through the automatic slicer.

The cooking and baking of food was accomplished in an average of 0.25 man-minute per meal. Here, size of operation as well as type of equipment appeared to influence time requirements. In school B where range tops and stack ovens were used 0.32 man-minute was needed, whereas in the largest kitchen, school E, where compartment steamer, steam-jacketed kettles, and the more compact convection-current baking ovens were used only 0.21 man-minute yielded the same results. Steam cooking equipment needs less attention than stock pots on a range top. Also, the larger quantities that can be prepared in the steam cooking equipment spread the labor effort over a greater number of meals, cutting down the per-meal labor requirement. Deck ovens with inside light and viewing windows and ovens with freely adjustable shelves were said to offer both added convenience and reductions in labor requirements.

Serving of Food

Setting up the serving line and actually serving food to students took nearly as long as preparing and cooking the food. Average time for serving was 1.24 man-minutes per meal, or 23 percent of total labor time. The range of 0.70 in school F to 2.37 man-minutes in school B reflects the different methods used. Variations in physical facilities and scheduling of students through the serving line also influenced labor requirements.

Setting up the serving line includes all preparatory activities at the serving line and in the lunchroom. Examples of these activities are moving hot food from the cooking area into the hot food section of the serving line, displaying cold food on the serving counter, filling the cooler with milk from the walk-in refrigerator, checking the availability of trays, dishes, and silverware, refilling salt and pepper and ketchup dispensers on the tables, and wiping tables for the next occupants.

Two major factors that affect the time required for all these activities are the distance of the serving line from the kitchen area, and the practices used in serving. If cold foods are displayed on individual dishes, time for setting up the serving line will be increased, but time needed to serve the students will be less than if foods are dished onto trays as the students move past the counter. Average time needed for setting up the serving line was 0.38 man-minute, with a range from 0.13 in school A to 0.64 in school E. In school A, a small grade-school kitchen, the serving lines were located in the kitchen. Only hot plate lunches were served, and no individual dishes were involved. The delivery man placed the milk into the serving line cooler, so that no kitchen labor was needed for this activity. In school E, a high school, the foods were displayed on individual plates, and students had a limited selection among foods, consistent with Type A lunch requirements. Foods were also served on individual plates in schools D and F where the time to set up the serving line was relatively high.

The serving of food includes the time of personnel behind the serving line. The activities of the cashier at the end of the line are included under the "Administration" category. Time spent by serving-line personnel replenishing food supplies at the serving line during the lunch hour was included under "setting up of serving line."

Average time needed to serve food was 0.86 man-minute per meal. Since it amounted to 13.6 percent of total labor time, it deserves careful study. The range from 0.17 man-minute in school F to 2.15 man-minutes in school B indicates that there are factors that can influence labor requirements. One of these factors is the distance of the serving line from the kitchen. Although this is an important determinant of the time needed to set up the serving line, it is even more significant in determining time spent in the actual serving.

The reason this distance is so significant in determining serving time is that even with the best scheduling of classes through the serving line the requirement for workers attending that line will vary. If the line is located within or adjacent to the kitchen, workers generally replenish supplies at the serving line, or perform minor tasks in the kitchen, as breaks in the serving line occur. But if the distance to the kitchen is too great, they will remain at their positions, even if they are not needed at that moment.

The second factor influencing labor requirements for serving is the use of individual dishes for salads and desserts, prepared before the students' arrival. This increases labor requirements for that activity, but once the students start moving through the line, the prior preparation of these dishes permits faster movement and requires fewer attendants behind the counter.

A limited choice of foods and the activities

of the cashier at the end of the line did not create any bottlenecks in the movement of students through the line. Also, use of student help (for example, in the handing out of milk cartons) did not have any adverse effect upon labor time required for serving. Finally, the speed with which the serving line was moving was not believed to affect labor time significantly.

School B, with the highest labor requirements, used an entirely different method of serving students. In this school, the food, already on plates, was carried by student helpers to the tables before the students arrived. This method resulted in higher labor requirements and an undesirable drop in the food temperature.

Cleanup Activities

The washing of dishes and pots and general daily cleanup of kitchen and lunchroom took a very significant share of total labor time. The average observed for these activities was 1.63 man-minutes, or 29.6 percent of total labor time. Practices varied considerably, with students, part-time, and full-time help doing the dishwashing, and janitorial or kitchen personnel doing the daily cleanup chores. Variations in total time used, however, were extremely small.

Dish- and pot-washing took an average of 0.98 man-minute per meal. Here, differences in physical facilities and setup appeared to explain more of the variation in time (0.78 man-minute in school D to 1.27 man-minutes in school A) than the participation of students or part-time help. School D had adequate space at the pot sink, and final hot rinsing of pots was done in the dishwashing machine. The dishwashing machine was a single-tank, door-type model, and its use extended over 2½ to 3 hours per day. The dishwashing layout was very functional, with a reach-through window from the lunchroom, and a food waste disposer built directly into the sink for rinsing the dishes. The dishwashing load consisted of divided plastic trays and individual dishes for salads and some hot foods. In school E, which had the second lowest dishwashing time, a continuous-racking conveyor dishwasher was used.

In schools with greater labor for washing pots and dishes there were usually inadequate pot sink and drainboard space, a dishwashing layout away from the lunchroom requiring extra workers for the collection of dishes at a central table in the lunchroom, and the need for supervisory personnel to oversee students perform the dishwashing operation. Only in one case was the dishwashing layout not adjacent to the lunchroom. In all the schools, students were required to deposit their soiled dishes at a central location.

General cleanup activities include daily sweeping of the lunchroom floor and mopping of the kitchen. (They do not include the more infrequent scrubbing and waxing of the lunchroom floor.) Average time needed for these general cleanup activities (except those discussed previously under "Getting Ready for Meal Preparation") amounted to 0.65 man-minute per meal. In most kitchens, the janitor cleaned the floors, but in one operation the women in the kitchen handled all cleanup chores. Practices did not vary significantly. Cleaning time varied little (from 0.52 to 0.71 man-minute per meal) in spite of noticeable differences in who did the cleaning and how much space had to be cleaned per meal served.

Incidental Activities

Activities incidental to school lunch operations, but not directly associated with the physical preparation of meals, took 0.76 man-minute per meal, or 13.5 percent of total labor time. Variation among different schools ranged from 0.50 in school B to 1.04 man-minutes in school F.

The greatest part of these incidental activities was the administration and supervision of kitchen operations. This category includes the time spent by the head cook or lunchroom supervisor in supervising or instructing kitchen workers, checking bills, writing supply needs, and conferring with cooks regarding the menu. It also includes the sale of lunch tickets to students, cashiering by persons designated to this task (which may be cooks, part-time helpers, the school secretary, or even students), and the counting of money, reconciliation of records, and banking done by kitchen supervisory personnel. Whenever lunchroom supervisors were in charge of more than one school kitchen, their working time was prorated among the schools on the basis of their own estimates.

The variation in time used for supervision, administration, and planning was not as much as that in some of the physical activities. Average time devoted to administration and planning was 0.44 man-minute per meal, with a range from 0.35 in school A to 0.54 in school E. In school A the manager worked in the kitchen full-time and did her administrative work between tasks. In school E a full-time lunchroom supervisor maintained cost-accounting records and followed up potential problem situations and ideas that might help to improve overall operations.

In every operation, whether it be a production line or office work, there are some unavoidable delays. The average 0.26 man-minute of delays per meal encountered in school lunch operations (4.5 percent of total labor time) is significantly lower than one would expect in the average pro-

duction situation. Yet the amount of nonproductive time per meal can vary significantly. The lowest figure observed was only 0.04 man-minute of unavoidable delay time occurring in school D. This low delay can be attributed to good coordination of efforts, and a scheduling of the working hours of full-time and part-time workers that coincided closely with the variations in the total work load during the day. On the other hand, the high delay of 0.46 man-minute in school F and 0.42 man-minute in school C was caused primarily by the long travel distance from the kitchen to the serving line: workers could not work in the kitchen during breaks in the serving line.

Time taken by workers for personal needs and time unaccounted for amounted to a uniform low of approximately 1 percent of total working time in all the operations studied.

It is apparent that the labor time expended for different tasks in school kitchens is affected by a multitude of factors that can work either in favor of or against a reduction of total effort needed. Some of these balance each other; they reduce time needed to accomplish one task, but increase time needed for the completion of another. Furthermore, some task categories appear to lend themselves more toward a reduction in effort than others because of their size and variability. Thus, while every part of school lunch preparation should be looked at as a possibility for reducing labor requirements, the larger categories appear to offer the greatest opportunity for savings.

Specifically, good layout of facilities and availability of equipment will help reduce time needed for the preparation and cooking of food; attention to work practices can help lower the time needed for the serving activities in particular; and speed appears to be more of a governing factor in dishwashing and general cleanup time than differences in practices or work assignment.

Effect of Kitchen Layout on Labor Time and Effort

Since floorspace and layout within a kitchen are believed to have a strong influence upon both total labor time and effort required in the preparation of school lunches, separate observations were made to measure the influence of these two factors upon the amount of time spent working or walking or in delays. Kitchens in schools E and F were selected for these observations. Observations were confined to kitchen workers only; activities of lunchroom supervisors, student helpers, and janitors were not included.

The kitchen in school E had 1.0 square foot of floorspace per meal served daily, whereas school F had only 0.5 square foot, with about 45 percent of that space covered by equipment. Aisle space in school F kitchen was very narrow, and women at their work stations generally had to step aside to let somebody pass. The situation was made somewhat more tolerable because an alternative route from one end of the kitchen to the other was available through the lunchroom.

Observations were categorized into working, walking, and delays on the assumption that the basic work in any kitchen of this feeding volume is approximately the same. Thus, any undue increase in the time spent walking or being delayed would tend to indicate a less efficient working situation.

Results obtained did not give a clear indication that availability of floorspace alone makes utilization of labor efficient. Differences in layout of the two kitchens and other factors resulted in more of the labor effort going into the actual accomplishment of work in the school F kitchen than in the school E kitchen. This tends to verify another observation made at all six of the schools studied: the workers were conscious of the handicaps under which they had to work and tried to compensate for this by applying greater effort. This reflects well upon school kitchen workers in general, but school officials must recognize that work can be done more efficiently in a facility with a reasonable amount of space and a functional layout of work stations, not only in terms of time but also in energy expended.

Although the results of the additional observations in the two large kitchens did not adequately measure the advantage to its workers of a more spacious kitchen, they did reveal some interesting data. For instance, on the basis of the nearly 2,000 observations made, from 65 to 75 percent of total labor time is given to the actual doing of work. Between 15 and 25 percent of total time is spent walking, 9 to 12 percent is taken by delays, and 1 to 2 percent goes for personal needs and time unaccounted for.

Work in school kitchens is flexible in its timing. While 65 to 75 percent of total time was spent working, only 5 to 10 percent of total time was "equipment-controlled" work. Equipment-controlled work refers to a situation in which the presence of a worker at a piece of equipment is mandatory, and the speed of work is governed by the machine. An example would be the stirring of a stock-pot of food on the range top, the feeding of a food cutter in operation, or the loading of the dishwasher once it is in operation.

The flexibility offered, because by far the greatest part of working time is not equipment-

controlled in its timing, gives management a greater opportunity to shift workers around. On the other hand, it puts greater emphasis on the planning ability of individual workers, because they must frequently select the best sequence of operations on their own.

The 15 to 25 percent of total labor time devoted to walking reflects differences in size of kitchen, layout, and specialization of workers. During about one-third of the time spent walking (5 to 8 percent of total labor time) workers are transporting something. This may be the moving of pots and pans, or pushing a handtruck. The remaining trips reflect the need to change work stations frequently.

The 9 to 12 percent of total labor time taken by delays results as much from unavoidable delays as from the need to pause occasionally during an uninterrupted work shift of several hours. Unavoidable delays will take a greater part of total time if planning by management and individual workers is lacking, and if physical layout and aisle space impede the free flow of traffic. The 1 to 2 percent taken for personal needs or time unaccounted for are so minor that they need not be of concern.

Application of Findings in Other Schools

The six school kitchens, for which data in table 1 are shown, were selected because they were considered to have efficient operations. It is possible for school lunch managers to obtain a labor expenditure breakdown for their schools that will provide a meaningful comparison with schools included in the study. The suggested comparison developed by the manager would include a labor breakdown by major groups, such as getting ready or food preparation and cooking as shown in table 1, and would exclude a breakdown of labor expenditure within the major groups. It is suggested that the school lunch manager determine the number of meals prepared per day and read the descriptive information on the two schools studied that are the size of their operation.

Records should be developed for a period of 2 or 3 weeks on labor time spent by each person in the cafeteria in the five areas of the school lunch operation. The five areas include the major groups in table 1, getting ready, food preparation, serving of food, cleanup activities, and administration and planning. Figure 15 is an example of the type of form each employee should be requested to complete at the end of each day for the 2- or 3-week study period. The data should be summarized on a man-minute-per-meal basis which would make it comparable to the data collected in the schools studied and shown in table 1.

By comparing the data with that obtained in this study the manager can determine areas in which excessive labor is required. Once such areas are isolated it is possible to determine the cause or causes of excessive labor requirements and to develop ways of reducing the labor requirements.

Activity Study

Name Jane S. Johnson

Time Start Work 10:00 A.M. Time Finish 2:30 P.M.

Activity	*Minutes*
Getting ready (receive goods, maintain storage, setup and cleanup work station)	20
Food preparation and cooking (cooking, baking, salads, bread)	160
Serving food (includes setting up serving line)	50
Cleaning (includes dishwashing and general cleanup)	—
Administrative (includes cashiering, meal planning, and supervision)	10
Total time (excluding lunch)	240

FIGURE 15.—A sample form for determining labor requirements of each employee in school lunch operations.

Operating Costs and Cost Control

The primary objective of school lunch operations is to furnish students with nutritious and well-balanced meals. Yet, as part of a public institution, school lunch operations also have a responsibility for the wise and efficient use of funds in attaining their service objective. For this reason, operating costs and cost control are of as much concern in school lunch operations as they are in commercial establishments. This requires the maintenance and periodic analysis of records and the use of information derived from these records in future planning.

Types of Records and Cost Control

Regular and accurate accounting for all income and expenditures on an annual basis is a normal part of school and lunchroom administration. The form in which these records are kept is governed by local, State, and Federal regulations, and records are subject to external audit at least once a year.

Additional records are needed to comply with requirements for participation in the various Federal- and State-administered school lunch programs. These records relate primarily to the number of students buying lunches, compliance of the menu with nutritional requirements, and milk costs and consumption. Auditors and reviewers of the appropriate State department of education can provide guidelines for the proper establishment of these records.

Beyond the requirement of keeping track of all income and expenditures and number of meals served, school lunchroom supervisors are known to maintain their own inventory control systems and to give specific attention to economical purchasing. Sources of supply are evaluated in terms of price and quality of product, service, and reliability. Wherever prices of products are subject to seasonal fluctuations, purchases are timed to minimize cost. All of these practices will go a long way toward minimizing operating costs.

Financial accounting concentrates on the recording of past results. To make these data more meaningful from a performance standpoint, conventional accounting data must be converted into ratios of average food and labor costs per meal. The ratios should be compared with operating results achieved in other schools to get an indication of the relative standing of the operations.

As long as a comparison of past operating results of a given school kitchen with results in similar school lunch operations turns out favorably, there usually is no immediate cause for concern. But if the comparison shows that a given kitchen operation has been lacking in performance, the supervisor is confronted with the task of finding the causes for these shortcomings. Poor performance may be evidenced by higher-than-average food or labor costs per meal, an undue labor effort per meal in terms of time, or low or variable student participation in the lunch program throughout the year. This is where the value of cost-accounting records becomes apparent.

Cost accounting, as distinguished from financial accounting, concentrates on the recording and analysis of current data and performance. Usually these data are immediately converted into ratios, such as cost per meal, that permit an evaluation of stated goals. Thus, a lunchroom supervisor may have an established goal that average out-of-pocket food cost per meal served should not exceed 18 cents. If the preliminary cost calculations indicate that the menu specified for a given week results in average food cost of 20 cents, she will know immediately that she either must revise the menu for that week or compensate for it by drawing up a menu for the following week that will cost less than the average set as a goal.

The type of records used (and amount of time spent on maintaining them) need not be very elaborate. One record form being used in some schools is shown in figure 16. It can be adjusted to fit the needs and desires of the individual lunchroom supervisor, and may be reproduced locally. More elaborate versions, incorporating the data for an entire week on a single sheet, are available in printed form. If these records are maintained, no more than a half-hour of the head cook's or lunchroom supervisor's time should be involved.

The form can be used to advantage in menu planning as well as in checking performance after the day is over. Foods are listed in categories according to their nutritional value. This helps call attention to the relative cost of providing protein, vitamin, and carbohydrate requirements. Specific types and amounts of food used are listed in order that their total cost can be calculated. These costs usually can be derived from recent invoices. A check of the current inventory will verify that the amounts needed actually are on hand. A preliminary estimate of the number of meals to be served and an actual count later on are needed to convert the cost into a per-meal figure, which is the usual basis for comparing the expected or actual outcome with the results achieved at other times.

Labor requirements for food preparation will vary from one menu to another. In many instances, more uniform daily labor utilization is achieved by preparing certain foods a day ahead, particularly if labor requirements are low on one day and high on the next. Hence, it

Date:_____ Expected number of meals to be served:_____

Menu:

Foods used	Quantity	Unit cost	Total cost
Milk			
Protein-rich foods:			
Vegetables and fruits:			
Vitamin A foods:			
Vitamin C foods:			
Other foods:			
Bread, etc.:			
Butter, or fortified margarine			
Additional foods to meet energy needs:			
Total food cost			

Total labor cost and remarks:

Actual number of meals served .....

Total food cost per meal served .....

Labor cost per meal served .....

Amount of holdover and plate waste .....

FIGURE 16.—Sample form for daily cost accounting in school lunch operations.

is helpful for later analysis to record not only the total working hours logged on a given day, but to supplement this with comments on activities accomplished that were not related to the preparation of the menu for that day. In school kitchens where all employees serve on a fixed compensation contract, the labor cost figure for any given day will usually be the same. Yet, the recording of hours and extra activities will provide valuable information for later analysis and future planning of labor utilization.

The advantages of maintaining both daily cost-accounting records and the required financial accounts become especially evident if a change in operating procedures is planned, or if a new person is about to take over management duties. If, for instance, operating results for a given period reveal a need to reduce food cost per meal, a review of the cost-accounting records will show which menus were the most expensive, and how frequently they were served. Or these records might show that none of the menus contributed to the high average cost, but that a frequent overestimation of the number of students to be served caused greater quantities to be prepared than were needed. Or finally, it might turn out that certain foods were so unpopular with students that their appearance on the menu caused a significant decrease in meal participation for that day, thus increasing cost per student served. Being able to pinpoint the causes of the trouble, and what improvements can be expected from certain remedial actions, takes the guesswork out of corrective action that is inevitable when lunchroom supervisors rely entirely upon memory.

Another value of daily cost-accounting records is their aid in training new head cooks. Availability of working records to show how situations were handled successfully in the past is likely to reduce apprehension as well as the errors in planning that must be expected during the learning period. Also, in case of an unexpected change in management, the records will enable the incoming lunchroom manager to adjust her practices to insure maximum continuity of operations. The benefits derivable from a few minutes each day spent on formal planning and record-keeping beyond the mandatory part of the job are manifold. It is strongly recommended, therefore, that all managers, even those of small operations, formalize their planning and evaluation of results by putting the pertinent data on paper, rather than relying entirely on memory for the details.

Pertinent Cost Categories and Income

Pertinent categories of operating cost generally recognized in school lunch operations are direct labor cost, purchased food cost, the cost and value of donated food, and the value of services donated by the local school board.

Direct labor cost usually includes salaries and wages paid to kitchen personnel. In some instances, contributions to employee retirement funds and the salary of the lunchroom supervisor are included in the value of services donated by the school rather than being charged directly to the operation of the lunchroom. Direct labor cost will vary from one location to another, depending upon the efficiency with which labor is used (man-minutes of labor required for the preparation of one meal), and upon wage rates. Efficiency of labor utilization is under the control of local management. Wage rates, however, generally are set to compete with other employment opportunities in the community, and as such are not under the control of kitchen managers.

In this study, direct labor cost varied from 8 to 14 cents per meal. This variation was due as much to differences in wage rates as to differences in efficiency in labor utilization. Assistant cooks were mostly paid on an annual basis, with contracts ranging from $1,080 to $1,512. Based on actual hours of work, this amounted to a wage rate of $0.86 to $1.48 per hour, not including fringe benefits. Pay of kitchen helpers hired on an hourly basis ranged from $0.90 to $1.75. Especially in areas with high wage rates, close attention to labor efficiency is needed to keep costs down. Direct labor cost amounted to 30-40 percent of total costs in the six schools studied.

Cost of purchased food will vary with location, type of menu, and, most of all, the items included. Food costs reported at the six schools ranged from 14 to 21 cents per meal including the cost of milk purchased. This wide range is due primarily to the sale at some schools of food items in addition to Type A plate lunches. Depending upon menu practices, purchasing habits, and location of the school, food costs amounted to 55 to 65 percent of total costs at the schools studied. Less than 10 percent of costs were for nonfood items.

The value of USDA-donated foods used by the schools studied during the week of observations was assessed at an average of 5-6 cents per meal, priced at current market value. Actual costs to the school for this food were limited to delivery charges and amounted to only a fraction of a cent per meal served.

The value of services donated by the board of education usually is calculated several times during the school year to arrive at total local expenditures for the operation of the lunch program. Items included vary from one location to

the other. The following are representative types of charges:

- A fixed percentage of the total electric and heat bills
- A fixed percentage of the water and sewer bills
- Charges for kitchen refuse collection
- Fees for extermination and sanitation services
- Charges for labor and transportation of surplus commodity deliveries
- A prorated share of the janitor's and maintenance supervisor's salaries
- Employer's contributions to welfare programs for kitchen employees
- A prorated share of the payroll clerk's salary
- Salaries of lunchroom supervisors.

Although most of the above services of the local school system are taken for granted, they do represent actual costs that cannot be overlooked. Even if spread over a sizable number of meals, they can amount to as much as 5 to 6 cents per meal served.

Income from school lunches consists of meal charges to students and adults. These charges usually are set by the local board of education, and they can vary between elementary and high school students, students and teachers, and one location and another. Representative meal charges in the six schools visited were 25 and 30 cents for elementary students, 30 and 35 cents for high school students, and 40 cents for adults. The number of free meals furnished to needy students also varied. It was generally left to the school superintendent to verify the need and to distribute free meal tickets to students falling into this category.

RECOMMENDED FACILITIES, LAYOUT, AND EQUIPMENT

It has been emphasized in this report that differences in local conditions make it impossible to follow precisely any standard set of recommendations in planning and operating local school lunch programs. But the general principles and experiences of other schools discussed previously will become more meaningful if they are presented in a form that can actually be observed when visiting a well-planned school kitchen. For this reason, information contained in the previous two chapters has been combined into a description of recommended facilities and labor utilization for school lunch operations in three different size groups.

The plans presented in this chapter represent only one of the many equally acceptable solutions. Furthermore, under specific local conditions, departures from the standards incorporated in these model operations may well be necessary.

In the development of the following floor plans, lists of equipment, and suggested plans of labor utilization, three basic assumptions were made:

(1) The physical facilities for the school lunch operations would be part of the overall school complex. As such, their location and shape must be adjusted to fit into the overall plan.

(2) Growth potential must be provided. The recommended plans provide an increase of 50 percent in the number of meals to be served above the initial meal load. Any larger increase in the number of meals to be served is assumed to call for the construction of additional school facilities which would have their own kitchen space.

(3) The upward trend in labor cost will continue, probably at a greater rate than the upward trend in food cost. For that reason, floorspace, layout, and equipment were selected to make the most effective use of labor.

Although these basic assumptions are generally applicable, local school officials will have to alter some of the basic relationships shown in the recommended plans to fit the underlying ideas into their own building program. Before they make such alterations, however, it is recommended that they review pertinent comments in the two previous chapters of the report. The reason for this is that some of the relationships and dimensions are more critical than others in their effect upon functionality of the facility and efficiency in labor utilization.

Facilities and Layout

Figures 17, 18, and 19 show floor plans for small, medium, and large school kitchen operations, respectively. Basic dimensions and floorspace recommended by each operation are summarized in table 2.

The type of floor plan presented in figure 17 for a kitchen designed to serve 350 to 500 meals per day is patterned closely after a standard plan that has been used by a large school district in several of its past construction projects. Kitchen personnel throughout this district are fully satisfied with the functionality of the layout, and measurement of labor requirements

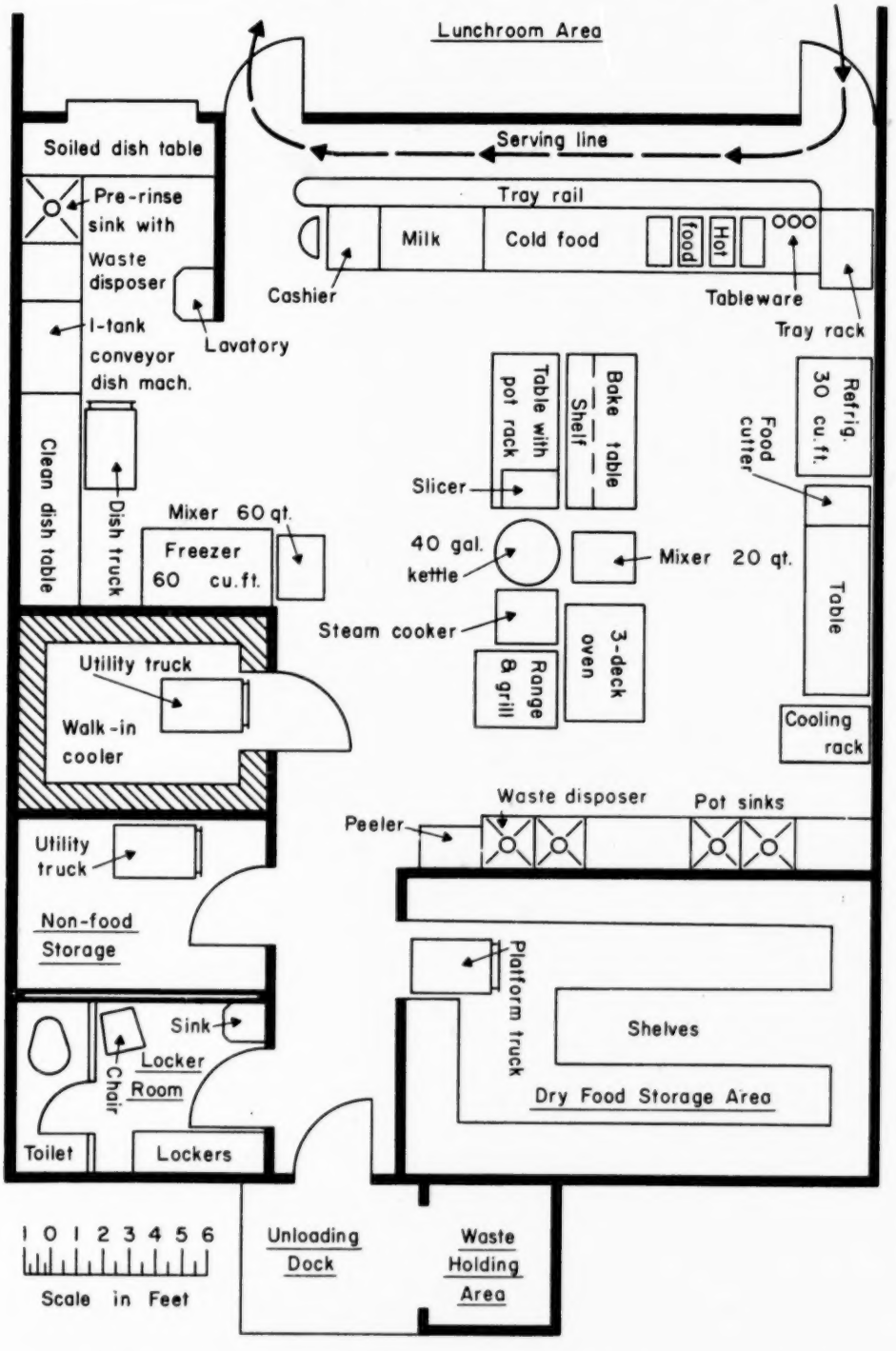


FIGURE 17.—Recommended kitchen layout for a school lunch operation designed to provide 350 to 500 meals a day.

during this study indicated that it is an efficient plan.

In this floor plan, the back hallway is used as a receiving area. However, a separate waste-holding area outside the back door has been added to avoid holding empty cartons and cans in the back hallway until the janitor or trash removal truck picks them up. The floor plan does not provide separate office space. It is assumed that working records are maintained with the help of clipboards at the food storage room entry and near the cooking center. Desk space in the school office permits the kitchen manager to keep her permanent records there. As an alternative, a desk could be placed in the nonfood storage area, provided closets are used there for the storage of cleaning supplies.

The lunchroom, which should be adjacent to the serving line, is not shown in the sketch. It should provide at least 2,000 square feet of floorspace and approximately 200 seats. Shape and layout of the lunchroom will be governed by the overall building plan and the uses to which this room may be put in addition to being a dining area.

The floor plan for the medium-size operation (fig. 18) serving between 700 and 1,000 meals a day, includes two L-shaped serving lines as a part of the kitchen. Even though these require slightly more floorspace than straight serving lines, they are more easily fitted into the desired rectangular space of the overall kitchen area. The 10-foot opening from each serving area to the lunchroom can be closed with a folding door.

In this size of operation, unnecessary cross traffic must be avoided, since during the peak hours from 10 to 15 people will be active in the kitchen area. The vegetable peeler is placed close to the food storage area and rear hallway because potato peeling involves bulk and more odor and sanitation problems than other food-preparation activities. The preparation center for the main dish is located centrally, and close to the refrigerated storage area. All cooking and baking is placed together under one central hood and exhaust fan system, although some of the newer convection-current electric baking ovens may be placed elsewhere and vented separately without great cost. The salad center is somewhat distant from the walk-in refrigerator, but has its own reach-in refrigerator. The lunchroom (not shown) adjacent to the serving lines should provide at least 3,800 square feet of floor space and 400 seats.

Developing a layout for an operation providing up to 2,000 meals a day is a complex task. The greater distance between working areas and the greater bulk of materials to be handled make compromises that could be incorporated in a small plan much less acceptable. For that reason, fairly extensive experimentation with a rough sketch and templates to represent each piece of equipment will be required before a satisfactory layout can be developed.

In figure 19 an attempt is made to minimize the distances that materials must be moved. The receiving area is enclosed. From there, goods can be moved into the dry food storage area, or they can be received at the second doorway and transported directly into the refrigerated storage areas. The vegetable peeler and sink are along the direct line of travel between the food storage area and the cooking center. This is important, because at a volume of 2,000 meals per day, the quantity of potatoes that will have to move through this facility within one school year can easily exceed 20 tons. For the same reason, the cooking center is only a few

TABLE 2.—*Space recommended for 3 sizes of school lunch operations.*

Area	350–500 meals per day (200 seats)		700–1,000 meals per day (380–420 seats)		1,400–2,000 meals per day (550–600 seats)	
	Total	Per meal (range)	Total	Per meal (range)	Total	Per meal (range)
	Sq. ft.	Sq. ft.	Sq. ft.	Sq. ft.	Sq. ft.	Sq. ft.
Kitchen and serving:						
Food preparation, including refrigeration	540	1.5–1.1	980	1.4–1.0	1,470	1.0–0.7
Serving	200	.6– .4	620	.9– .6	1,100	.8– .6
Dishwashing	150	.4– .3	220	.3– .2	280	.2– .1
Food storage	230	.7– .5	460	.7– .5	800	.6– .4
Nonfood storage	70	.2– .1	70	.1– .1	120	.1– .1
Office, employees' dressing room, and rear hallway	160	.5– .3	250	.3– .2	430	.3– .2
Total	1,350	3.9–2.7	2,600	3.7–2.6	4,200	3.0–2.1
Receiving dock and waste-holding	70	.....	80	.....	200	.....
Lunchroom	2,000	.....	3,800	.....	5,500	.....
Per seat	10	.....	9–10	.....	9–10	.....

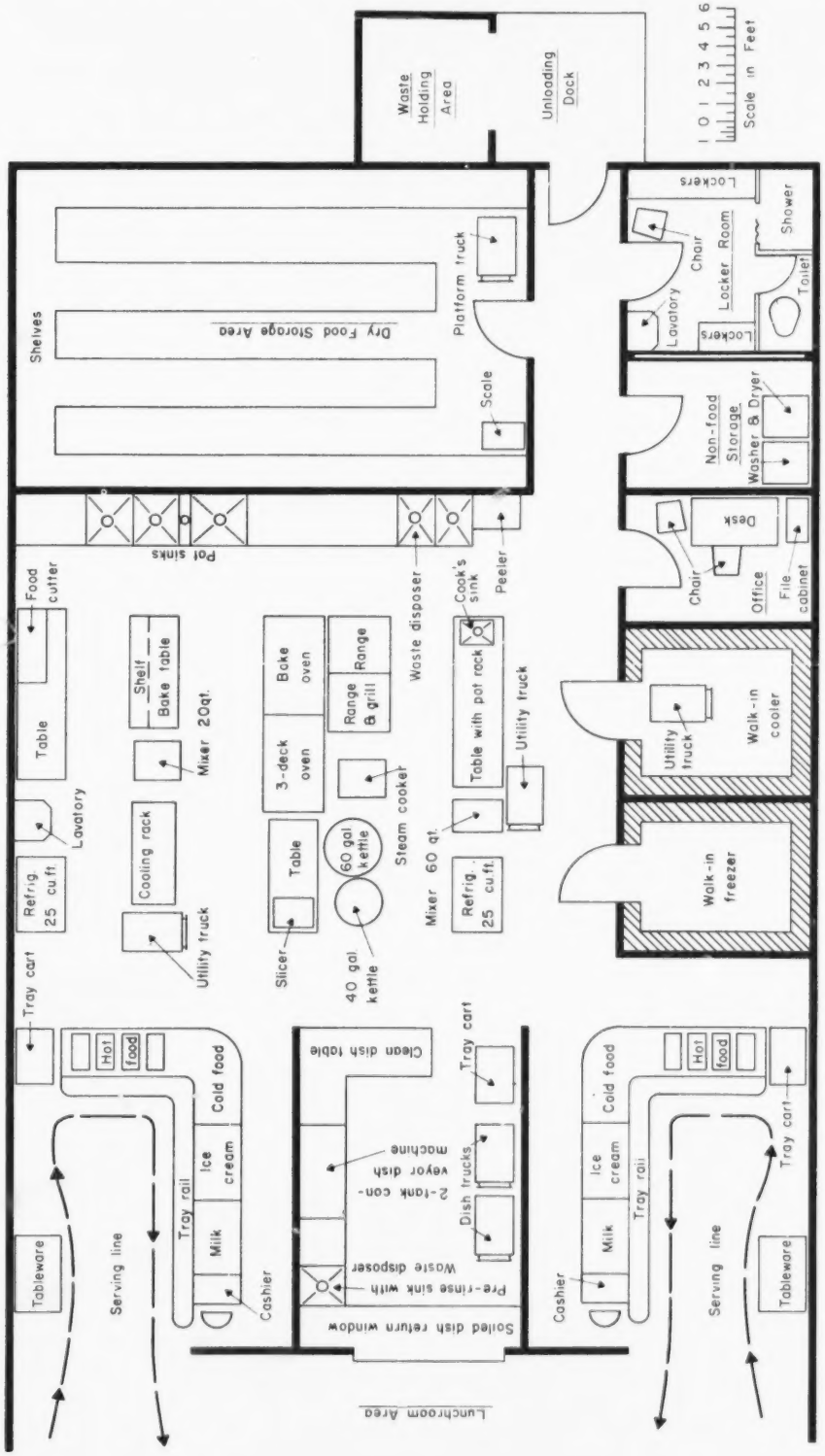


FIGURE 18.—Recommended kitchen layout for a school lunch operation designed to provide 700 to 1,000 meals a day.

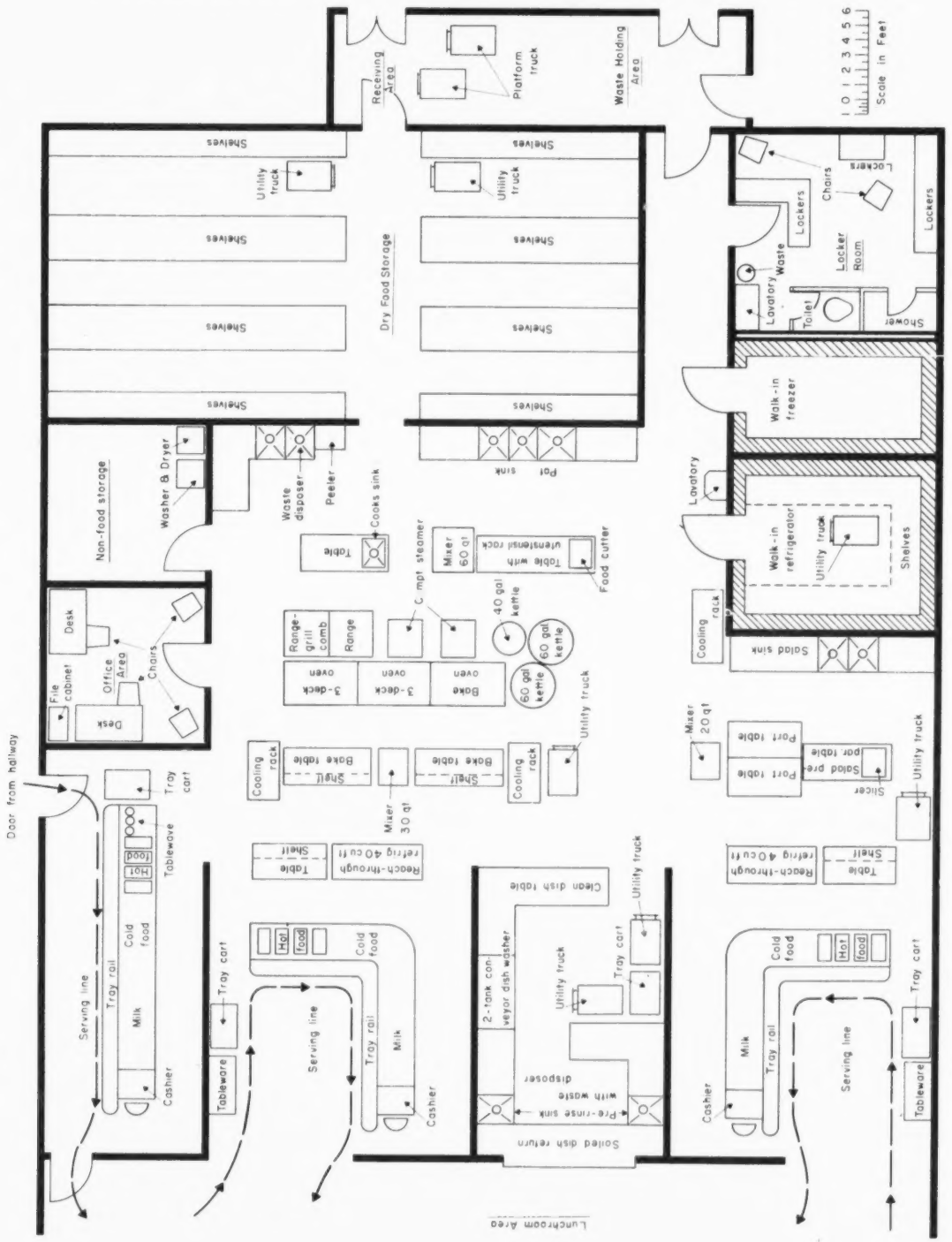


FIGURE 19.—Recommended kitchen layout for a school lunch operation designed to provide 1,400 to 2,000 meals a day.

feet from the food storage room. All aisles behind work stations are wide enough to permit someone to pass without interrupting the worker.

Two L-shaped serving lines and one straight line were selected to permit exit from all three lines into the lunchroom. The L-shaped serving lines can be closed off from the lunchroom by folding doors. Another possibility would be the separation of the serving lines from the kitchen by a wall, with reach-through refrigerators behind the serving lines becoming part of the wall. The dishwashing area is large enough to permit installation of a continuous-racking type of dishwasher. The lunchroom for this kitchen operation should provide at least 5,500 square feet of floorspace.

Equipment

Major equipment needed for the operation of the three suggested facilities is listed in table 3. The types of equipment suggested were discussed previously. The equipment is sufficient for production of the number of meals at the upper end of the feeding range quoted, except in the largest operation. It may not be necessary at the beginning to install all the equipment shown, as long as the peak meal load will not be reached for a few years. However, if such a decision is reached, the spaces intended for the later installation of the equipment and the necessary utility lines should be provided so that no changes or additions will be necessary except for installation of the equipment itself.

Cooking in these kitchens is oriented toward the use of steam equipment, because of the greater speed, labor savings, and higher capacity of this type of equipment. Some range space is available, but those kitchen managers who have adapted their operations entirely to steam cooking may find no need for the range space. In the large operation, 1,500 students probably can be fed per day with two triple-deck bake ovens as a minimum. Also, the third mixer in the largest operation probably will not be required until the kitchen is used to maximum capacity of 2,000 meals.

The capacity of the potato peelers in all three models is intentionally kept low, since the newer models take only a few minutes to process one load and can turn out the quantity of peeled potatoes needed within a short time. Loads of more than 30 pounds would be difficult to handle when no male help is available.

TABLE 3.—*Equipment required for recommended kitchen layouts, 3 sizes of school lunch operations.*

Equipment	350–500 meals per day		700–1,000 meals per day		1,400–2,000 meals per day	
	Number	Type	Number	Type	Number	Type
Cooking and baking equipment:						
Range, with combination grill surface, 30-36 in. wide	1	(with oven below)	2	.....	2	.....
Compartment Steamer, 3 compartments	1	.....	1	.....	2	.....
Steam-jacketed kettle	1	40 gal.	1	60 gal.	2	60 gal.
			1	40 gal.	1	40 gal.
Oven for baking and roasting	1	3 deck	1	3 deck	2	3 deck
Oven for baking, adjustable shelves, convection current	....	.....	1	.....	1	.....
Hood or canopy, above all cooking and baking equipment, with exhaust fan, filters, and lights.	1	8 x 10 ft.	1	8 x 18 ft.	1	8 x 22 ft.
Mechanical equipment:						
Mixer, with portable stand	1	20 qt.	1	20 qt.	1	20 qt.
Mixer, floor model	....	.....	....	.....	1	30 qt.
Mixer, floor model, with bowl dolly and adapters for 30 qt.	1	60 qt.	1	60 qt.	1	60 qt.
Mixer attachments:						
9-in. vegetable slicer	1	.....	1	.....	1	.....
Dicer	1	.....	1	.....	1	.....
Meat and food chopper	1	.....	1	.....	1	.....
Vegetable peeler, with cabinet base and trap	1	15–20 lb.	1	15–20 lb.	1	30 lb.
Food cutter	1	.....	1	.....	1	.....
Food slicer, angle feed	1	10- to 12-in. blade	1	10- to 12-in. blade	1	10- to 12-in. blade
Food waste disposer	1	1½ hp.	2	1½ hp.	2	1½ hp.

TABLE 3.—*Equipment required for recommended kitchen layouts, 3 sizes of school lunch operations—continued*

Equipment	350–500 meals per day		700–1,000 meals per day		1,400–2,000 meals per day	
	Number	Type	Number	Type	Number	Type
Refrigeration equipment:						
Walk-in refrigerator	1	8 x 10 ft.	1	8 x 12 ft.	1	10 x 12 ft.
Reach-in refrigerator, at work stations	1	30 cu. ft.	2	25 cu. ft.	....	.....
Reach-through refrigerator, behind serving line	....	.....	....	.....	2	40 cu. ft.
Walk-in freezer	....	.....	1	8 x 10 ft.	1	8 x 12 ft.
Reach-in freezer	1	60 cu. ft.	....	.....	....	.....
Sinks:						
Sink in cook's table	....	.....	1	1 compartment	1	1 compartment
Vegetable preparation sink	1	2 compartments	1	2 compartments	2	2 compartments
Vegetable sink drainboard area	1	3 ft.	1	4 ft.	1	14 ft.
Pot sink	1	2 compartments	1	3 compartments	1	3 compartments
Pot sink drainboard area	....	4 ft.	....	8 ft.	....	8 ft.
Hand lavatory	1	.....	2	.....	2	.....
Tables:						
Cook's table	1	Utensil rack	1	Utensil rack	1	Utensil rack
Food preparation table	1	Flat	2	Flat	3	Flat
Food preparation table	1	Back shelf	1	Back shelf	4	Back shelf
Table, silverware display	....	.....	2	.....	2	.....
Portable equipment:						
Landing tables	....	.....	....	.....	2	.....
Cooling racks	1	.....	1	.....	3	.....
Tray racks	1	.....	3	.....	4	.....
Utility trucks	3	2 or 3 decks	5	2 or 3 decks	6	2 or 3 decks
Handtruck	1	Heavy duty	1	Heavy duty	2	Heavy duty
Serving lines, complete, 4 rectangular openings, cold food section, cooler, silverware and cashiers sections, and tray rail	1	.....	2	.....	3	.....
Dishwashing equipment:						
Soiled-dish table	1	9 ft.	1	12 ft.	1	13 ft.
Sink for rinsing soiled dishes	1	.....	1	.....	2	.....
Automatic dishwasher	1	Single-tank conveyor	1	Double-tank conveyor	1	Double-tank conveyor
Clean-dish table	1	8 ft.	1	10 ft.	1	13 ft.
Auxiliary equipment:						
Washing machine	....	.....	1	Household	1	Household
Dryer	....	.....	1	Household	1	Household
Lockers, dressing room	5	.....	10		18	
Cot	....	.....	1		1	
Chairs	2	.....	3		4	
Kitchen stools	2	.....	3		4	
Desk and chair	....	.....	1		2	
File cabinet	....	.....	1		1	

An item that may be considered optional in the small volume kitchen is the food cutter. On the other hand, equipment that is valuable in any size of operation, yet often not found in smaller kitchens, includes the utensil rack on top of the cook's table and the portable cooling rack for holding hot baking sheets or pans of food stacked on top of each other.

In the largest operation, reach-through refrigerators are placed behind the serving lines to permit holding and passage of food from the kitchen to the serving lines. In the two smaller operations, reach-in refrigerators are placed next to the major work stations. However, in all cases, major dependence will be upon the walk-in refrigerator. Freezer space provided in all

three layouts should make these schools independent of the use of rented commercial freezer space.

All three of the recommended plans include automatic conveyor-type dishwashing machines. The larger models of this type of machine have proved adequate in operations feeding more than 1,500 students per day. However, because it is necessary to stack dishes in individual racks and because normal operating procedures permit only about 70 percent utilization of the stated capacity of the machines, dishwashing time may extend to 2 hours or more when individual dishes are used rather than divided trays. If a shorter dishwashing time is desired, a continuous-racking type of machine may be preferred.

For two seatings in the dining room, the number of dishes available should equal about two-thirds of the total daily meal load. This will assure flexibility when dishwashing operations cannot be started as soon as the first students leave the lunchroom.

Type and number of pots and pans will depend largely upon the preferences of the kitchen manager. For the operations discussed here, stainless steel cooking ware is recommended. Pans should be of standard size (12 by 20 inches) or half-size (12 by 10 inches) and varying depth (6, 4, or 2½ inches). Baking sheets should also be of standard size (18 by 26 inches). Small equipment is not listed in detail, since it is a matter of preference. Furthermore, if additional small equipment is needed, it can be obtained in a few days without major administrative approval.

Labor Requirements in Recommended Kitchens

Labor requirements for the preparation of Type A meals in the recommended kitchens are influenced somewhat by economies of scale in larger operations. This is reflected in the breakdown of labor time required per meal in each operation as shown in table 4. Activities included in each task category are the same as those discussed in the previous section entitled Labor Requirements in Schools Studied.

The labor requirements shown in table 4 for each size of kitchen operation (figs. 17, 18, and 19) include all people contributing to the operation of the kitchen and serving lines. These requirements are close to those observed under similar conditions in the six school lunch operations studied. The data are reasonably achievable averages for the preparation of menus similar to the ones shown on page 23, and staffing of facilities as indicated in table 5. Labor requirements shown in table 4 for kitchen personnel may be as much as 10 percent lower, depending on how much janitorial help is used in such tasks as receiving supplies and cleaning the lunchrooms and kitchens, and how many administrative duties are handled by a separate lunchroom supervisor rather than by the head cook.

Economies of scale in labor utilization exist primarily in the preparation and cooking of food, since the preparation of larger quantities of food and the use of higher capacity equipment are not always associated with a corresponding increase in labor requirements. On the other hand, the serving of food is more a matter of organizational talent and good timing, and small schools can be just as efficient as the larger schools. The same holds true for incidental activities.

Inasmuch as economies of scale are limited largely to the preparation and cooking of food, a task requiring from ¼ to ⅕ of total labor time, the differences in labor requirements per meal between the largest and the smallest facility are not as large as one might believe. Labor requirements per meal in the smallest kitchen are less than 15 percent higher than those in the largest kitchen. However, all three operations shown are designed on the same principles and incorporate basically the same type of equipment. Wherever facilities differ in their basic layout, type of equipment, and size, larger differences in labor requirements per meal must be expected.

Methods to be followed in the general operation of the facilities and in preparation and cooking of food are assumed to be the same in all three operations. The only deviation that may be necessary relates to serving practices. The serving practices of the small operation are likely to be more prevalent in elementary schools than those of the larger operations, because use of divided trays appears to be more widely accepted in elementary schools than service on individual dishes. The time requirements reflected in table 4 assume that in the 350- to 500-meal operation food is dished out on divided trays to students as they pass through the serving line. This calls for a relatively low setup time for the serving line, but a slightly longer time in serving. In the two larger operations, it is assumed that all side dishes (such as salads and desserts) are served on individual plates displayed in the cold food section of the serving line. This requires a slightly higher time for setting up the serving line, but the serving itself will be more rapid.

The staffing needed in the recommended kitchens will depend upon the volume of meals

TABLE 4.—*Time required to prepare Type A meals in recommended kitchen layouts, 3 sizes of school lunch operations.*

[Man-minutes per meal]

Function	350–500 meals per day	700–1,000 meals per day	1,400–2,000 meals per day
Getting ready:			
Receive goods and move into storage	0.07	0.06	0.06
Maintain storage and move goods out	.12	.10	.10
Setup and cleanup work stations	.21	.20	.18
Total	.40	.36	.34
Food preparation and cooking:			
Prepare for cooking	.53	.45	.41
Prepare for baking	.32	.25	.20
Prepare salads	.21	.15	.12
Prepare breads, etc.	.11	.08	.05
Cooking and baking	.25	.24	.22
Total	1.42	1.17	1.00
Serving of food:			
Setup serving line	.25	.55	.50
Serving	1.00	.70	.65
Total	1.25	1.25	1.15
Cleanup activities:			
Wash dishes and pots	1.00	.95	.90
General cleanup	.65	.60	.60
Total	1.65	1.55	1.50
Incidental activities:			
Administration and planning	.45	.50	.45
Delays	.28	.31	.30
Personal needs	.05	.06	.06
Total	.78	.87	.81
Grand total	5.50	5.20	4.80

to be prepared. The number of people in various jobs are shown in table 5. The lower number of people in each category relates to an output equivalent to the lower number of meals per day for which the facility was designed, whereas the larger number of people should permit operation at the upper limits of output shown. Total man-hours per day expended in the entire operation are consistent with the per-meal labor requirements shown in table 4.

In table 5, personnel assignments are described in general terms only. Each of the assistant cooks should be able to perform the job of the others if the need arises. However, it is assumed that each of the senior assistant cooks is responsible for the preparation of food in a given department, such as main dish, salads, desserts, or baking. Such assignment of responsibilities helps increase pride of individuals in their work and permits maximum advantage from specialization.

Most of the work is performed by full-time employees. Nevertheless, it is desirable to level peak workloads during the day by using part-time workers who come in primarily during the noon hours. Since no student help is used in the recommended operations, the part-time help needed must consist of workers from the outside, who come in each day for a 3- to 4-hour period. A record of their daily working hours is kept, and they are paid on an hourly basis.

All kitchen workers are assumed to be women, as is generally the case. However, in the largest of the operations, one of the assistant cooks

TABLE 5.—*Suggested personnel assignments and working hours for preparing Type A meals in recommended kitchen layouts, 3 sizes of school lunch operations.*

Size of operation and worker assignment	Duties	Workers[1]	Regular working hours[2]	Total man-hours per day[1]
350–500 MEALS PER DAY				
Head cook	Planning, supervising, and participating in kitchen work; inventory control; general administration.	1	7:30 a.m. to 2:00 p.m.	6
Assistant cooks	Preparation of food, cooking, baking, serving, (1 person at cash register during serving hours); general cleaning, receiving goods, storeroom maintenance.	3–4	7:30 a.m. to 2:00 p.m.	18–24
Kitchen and lunchroom helpers.	Setting up serving line; dishwashing; and general cleaning.	2–4	10:30 a.m. to 2:00 p.m.	6–12
Janitor	Cleaning lunchroom and kitchen floor; disposing of trash.	1	Intermittent	2
Total	.....	7–10	.....	32–44
700–1,000 MEALS PER DAY				
Lunchroom supervisor	Administrative duties, planning and supervising school lunch operations.	1	Intermittent	3–4
Head cook	Planning, supervising and participating in kitchen work; inventory control; maintaining records.	1	7:00 a.m. to 2:30 p.m.	7
Assistant cooks	Preparing food, cooking, baking, serving, and general cleaning; receiving goods; storeroom maintenance; operating cash register during serving; wiping tables in lunchroom as needed.	6–9	7:30 a.m. to 2:00 p.m.	36–54
Kitchen and lunchroom helpers.	Setting up serving line; wiping tables in lunchroom; general cleaning.	1–2	10:30 a.m. to 2:00 p.m.	3–6
Dishwashers	Washing dishes, pots, pans; general cleaning.	3–4	10:30 a.m. to 2:00 p.m.	9–12
Janitor	Cleaning lunchroom and kitchen floors; disposing of trash; assisting in heavy lifting when needed.	1	Intermittent	3–4
Total	.....	13–18	.....	61–87
1,400–2,000 MEALS PER DAY				
Lunchroom supervisor	Administrative duties; planning and supervising school lunch program; central purchasing of food and supplies.	1	Intermittent	4–5
Head cook	Planning, supervising, and participating in kitchen work; receiving goods; inventory control; maintaining records.	1	7:00 a.m. to 3:30 p.m.	7–8
Assistant cooks	Preparing food, cooking, baking, serving, and general cleaning; receiving goods; storeroom maintenance; operating cash register during serving; wiping tables in lunchroom as needed.	10–15	7:30 a.m. to 3:00 p.m.	70–105
Kitchen and lunchroom helpers.	Setting up serving line; wiping tables in lunchroom; general cleaning.	3–4	9:30 a.m. to 2:00 p.m.	12–16
Dishwashers	Washing dishes, pots, pans; general cleaning.	4–5	10:30 a.m. to 3:00 p.m.	16–20
Janitor or maintenance supervisor.	Cleaning lunchroom and kitchen floors; disposing of trash; assisting in heavy lifting when needed.	1	Intermittent	3–6
Total	.....	20–27	.....	112–160

[1] Range refers to operation of facility at lower and upper limit of output.
[2] All kitchen workers take ½-hour for lunch.

might profitably be a full-time male kitchen helper. His duties would consist primarily of moving bulky supplies, such as potatoes and case goods, and many of the minor maintenance jobs that otherwise would be performed by the janitor.

Reliance upon janitorial assistance for cleaning floors is limited to weekly major scrubbing of floors and waxing or polishing lunchroom floors where applicable. These tasks usually are done at times other than the regular hours of kitchen and lunchroom operation. No provisions are made for annual inventory and cleanup activities.

BIBLIOGRAPHY

(1) ANDERSON, K. E.
1958. SCHOOL LUNCH PROGRAMS IN ELEMENTARY AND SECONDARY SCHOOLS OF THE UNITED STATES. U.S. Dept. Agr. Mktg. Res. Rpt. 262, 48 pp. Washington, D.C.

(2) ANDERSON, K. E., and HOOFNAGLE, W. S.
1960. THE MARKET FOR FOOD IN PUBLIC SCHOOLS. U.S. Dept. Agr. Mktg. Res. Rpt. 377, 58 pp., illus. Washington, D.C.

(3) BARNES, R. M.
1957. WORK SAMPLING. 2d ed. John Wiley & Sons, New York, N. Y.

(4) DAVIS, R. C., and FILLEY, A. C.
1962. PRINCIPLES OF MANAGEMENT. Alexander Hamilton Institute, Inc., New York, N. Y.

(5) DONALDSON, BEATRICE, and PROUD, DOROTHY.
1964. SELECTING, ARRANGING AND USING FACILITIES FOR SCHOOL LUNCH PROGRAMS. Univ. of Wis., Bul. 567, 24 pp. illus.

(6) KOTSCHEVAR, L. H. and TERRELL, M. E.
1961. FOOD SERVICE LAYOUT AND EQUIPMENT PLANNING. John Wiley & Sons, Inc., New York, N. Y.

(7) MAYER, R. R.
1962. PRODUCTION MANAGEMENT. McGraw-Hill Book Company, Inc., New York, N. Y.

(8) UNITED STATES DEPARTMENT OF AGRICULTURE.
1956. A GUIDE FOR PLANNING AND EQUIPPING SCHOOL LUNCHROOMS. U.S. Dept. Agr. PA–292, 60 pp., illus. Washington, D.C. (Reprinted April 1962.)

(9) ———
1959. FOOD STORAGE GUIDE FOR SCHOOLS AND INSTITUTIONS. U.S. Dept. Agr. PA–403, 42 pp. illus. Washington, D.C. (Reprinted March 1965.)

(10) ———
1961. THE NATIONAL SCHOOL LUNCH PROGRAM — FIFTEEN YEARS OF PROGRESS, 1947-1961. U.S. Dept. Agr. PA–469, 20 pp., illus. Wash. D.C.

☆ U. S. GOVERNMENT PRINTING OFFICE : 1969 O - 356-908

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
HYATTSVILLE, MARYLAND 20782

OFFICIAL BUSINESS

POSTAGE & FEES PAID
United States Department of Agriculture